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Geraghty & Miller, Inc.

GROUNDWATER QUALITY ASSESSMENT PROGRAM OF THE PPG MERCURY POND FACILITY NATRIUM, WEST VIRGINIA

Prepared for:

PPG INDUSTRIES, INC.
NATRIUM, WEST VIRGINIA

DECEMBER 1983

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SUMMARY

During October, 1983, PPG Industries, Inc., retained Geraghty & Miller, Inc., to design a program to assess groundwater quality in the vicinity of a surface impoundment (referred to as the Mercury Pond) being used at their Natrium, West Virginia plant site. This program was initiated because groundwater monitoring data (detection monitoring under 40 CFR 265 Subpart F) for the Mercury Pond facility indicated that levels of total organic carbon (TOC) and specific conductivity (SC) in all of the downgradient monitor wells (GM-1, GM-2, and GM-6) were, by statistical interpretation, significantly higher than were found at the GM-0 (or STB) production well selected to represent background water-quality conditions.

The primary objective of the groundwater quality assessment program (required under 40 CFR 265.93(d)(2)) was to determine if the Mercury Pond is responsible for the statistically higher TOC and SC levels. In pursuing this objective, two sets of water samples were collected from the Mercury Pond and the three downgradient wells, and laboratory analyses were conducted for major cations and anions as well as other selected parameters (see Table 2 for results). These data were then inspected for water-quality

relationships (i.e., specific parameters and/or parameter relationships) relative to whether or not Mercury Pond fluids have affected groundwater quality in downgradient monitor wells.

Based on Geraghty & Miller, Inc.'s, interpretations of the available data, it appears likely that higher-than-background levels of TOC and SC in downgradient monitor wells are due to sources other than the Mercury Pond. It is thought that statistically higher TOC levels reflect a somewhat greater abundance of natural TOC source materials (e.g., coal and disseminated organic matter) in the downgradient monitoring area, relative to the background monitoring area. Significantly higher SC levels in downgradient wells are believed to be related to past (and discontinued) practices when the pond existed as a concrete-lined facility that was used for brine storage (from 1943 until about 1960); in 1970, the facility was reactivated as the Mercury Pond, which is equipped with an impermeable synthetic-liner.

BACKGROUND INFORMATION

The surface impoundment at PPG's Natrium, West Virginia plant site was initially used (from 1943 until about 1960) as a storage basin for sodium chloride brine produced from deep wells tapping Silurain-age deposits; during this period, the impoundment was concrete lined. After more than a decade of retirement, the facility was refurbished and equipped with an impermeable synthetic liner that has been used since 1970 to contain waste flow from the plant's mercury cell, chlorine circuit. Fluids currently entering the pond have a brine-type composition, characterized by a high pH (11.5 to 12.0) and appreciable concentrations of dissolved mercury (350 micro-gram/liter range). The mixed mercury waste within the pond is precipitated as mercury sulfide and the resultant clarified liquid is treated via carbon filtration prior to discharge into the Ohio River. The Mercury Pond is periodically cleaned and the liner has been replaced once.

The Mercury Pond facility is situated upon naturally high ground located immediately adjacent to the east valley wall of the Ohio River. Beneath this area, the alluvial aquifer (the uppermost water-bearing unit) abruptly pinches out against the steeply rising bedrock deposits of the valley wall. Owing to these conditions, the monitor well installed topographically upgradient from the Mercury Pond failed to intercept the uppermost aquifer; i.e., bedrock was encountered at an elevation higher than the water table. This necessitated the use of an alternative sampling location (GM-0) to characterize background water quality at the Natrium site.

The GM-0 (or STB) well is a plant pumping well and is located roughly two thousand feet west of the Mercury Pond, toward the Ohio River. In selecting this well to represent background water quality, several important criteria had to be met; these include: 1) the well had to be virtually free of contamination, 2) the well had to be situated so as not to intercept groundwater emanating from beneath the Mercury Pond, and 3) water produced from the well should represent natural aquifer fluids, and not induced recharge from the Ohio River. Unfortunately, site geologic conditions did not permit compliance with a fourth important criterion; namely, the background well and the three downgradient monitor wells (GM-1, GM-2, and GM-6) should be installed into deposits of similar lithology. Downgradient wells are installed through predominantly silt- and clay-rich materials largely derived from weathering and mass-wasting of the valley wall (rock fragments are common) whereas deposits beneath the GM-0 location are probably comprised mainly of clean sand and gravel representing glacial outwash (geology beneath the GM-0 location is inferred by nearby wells for which logs are available).

Results of the groundwater monitoring program conducted under 40 CFR 265 Subpart F (detection monitoring) do indicate a statistically significant difference in water quality between the background and the downgradient wells; specifically, downgradient wells GM-1, GM-2, and GM-6 contain higher concentrations of TOC and are characterized by higher specific conductivities than were observed in the GM-0 background well. However, supplemental water-quality data generated throughout the course of 1982 detection monitoring (Table 1), and recent data generated as a result of this water-quality assessment program (Table 2) suggest that:

1) Higher-than-background TOC levels in downgradient monitor wells are probably reflective of differences in lithology between the background and the downgradient monitoring areas, and

2) Significantly higher SC levels in downgradient wells are probably mainly related to seepage that occurred several decades ago, when the pond existed as a cement-lined brine storage facility.

The specific rationale behind these interpretations are discussed in the following report sections.

TABLE 1.

AVERAGED RESULTS OF WATER-QUALITY ANALYSES CONDUCTED DURING 1982 DETECTION MONITORING AT THE PPG MERCURY POND FACILITY

(averages represent mean of 1/4/82, 5/10/82, 8/3/82, and 11/15/82 water-quality data; all values are expressed in mg/l unless otherwise specified)

Well Number	pH (Std. units)	SC (umhos/cm)	TOC	TOX (ug/l)	TDS	Total ALK. (as $CaCO_3$)	HCO_3	Cl	SO_4	Na	K	Ca	Mg	Fe	Mn	Hg (ug/l)	Na/Cl
GM-0	7.1	618	3	49	399	287	350	21*	80	11	2	108	11	0.1	<0.01	<0.2	0.5
GM-1	7.2	995	17	77	619	506	617	25	4	136	2	116	32	29	1.5	<0.5	7.5
GM-2	7.1	1249	7	48	779	504	615	69	9	245	5	107	25	11	2.7	<0.5	3.9
GM-6	7.2	896	10	26	585	259	317	68	123	130	5	103	15	6	2.1	0.4	2.1

* Median value used because of anomously high result in 1/4/82 analysis.

TABLE 2.
RESULTS OF CHEMICAL ANALYSES CONDUCTED DURING THE WATER-QUALITY ASSESSMENT PROGRAM
AT THE PPG MERCURY POND FACILITY
(all values expressed in mg/l unless otherwise specified)

Well Location	pH (std. units)	SC (umhos/cm)	TOC	TDS	Total ALK. (as $CaCO_3$)	HCO^3	Cl	SO_4	Na	K	Ca	Mg	Fe	Mn	SiO_2	Hg (ug/l)	Na/Cl
10/19/83 Sample Set																	
GM-0	6.9	678	1.2	425	212	259	19	84	-	-	-	-	-	-	-	-	-
GM-1	7.1	1158	9.0	650	602	734	18	<10	122	1.4	100	29	0.1	1.0	11.5	<0.5	6.8
GM-2	7.0	1355	5.7	758	596	727	79	<10	172	3.0	99	23	0.9	1.7	13.4	<0.5	2.2
GM-6	7.3	1050	7.4	635	207	253	61	188	97	2.7	98	16	<0.1	0.7	8.5	<0.5	1.6
Hg Pond	11.6	91625	4.0	85950	1424	1737	49000	1640	35200	19.4	13	<1	<0.1	<0.02	31.4	347	0.72
10/27/83 Sample Set																	
GM-0	7.1	719	1.4	485	202	246	27	84	-	-	-	-	-	-	-	-	-
GM-1	7.2	1178	8.1	675	599	731	49	<10	123	1.5	103	28	10.7	1.1	11.8	0.5	2.5
GM-2	7.0	1369	3.1	743	579	706	84	<10	203	3.2	92	21	5.1	1.5	13.8	<0.5	2.4
GM-6	7.2	1055	5.5	610	202	246	69	177	X	X	X	X	X	X	X	X	X
Hg Pond	12.0	61500	3.9	52400	5854	7142	29000	840	22000	17.4	16	0.1	.1	<0.02	19.3	350	0.76
Mean Average of 10/19/83 and 10/27/83 Data																	
GM-0	7.0	699	1.3	455	207	253	23	84	-	-	-	-	-	-	-	-	-
GM-1	7.2	1168	8.6	663	601	733	34	<10	123	1.5	102	29	5.4	1.1	11.7	<0.5	3.6
GM-2	7.0	1362	4.4	751	588	717	82	<10	188	3.1	96	22	3.0	1.6	13.6	<0.5	2.3
GM-6	7.3	1053	6.5	623	205	250	65	183	97*	2.7*	98*	16*	<0.1*	0.7*	8.5*	<0.5*	1.6*
Hg Pond	11.8	76563	4.0	69175	3639	4440	39000	1240	28600	18.4	15	<1	<0.1	<0.02	25.4	349	0.73

- Not analyzed

X Insufficient sample volume for analyses

* Value based entirely on 10/19/83 data

DISCUSSION OF TOTAL ORGANIC CARBON ANALYSES

Total Organic Carbon (TOC) values in groundwater can reflect natural, as well as artifically induced sources of organic carbon. In uncontaminated groundwaters, natural TOC levels typically range from <5 to 10 or more milligrams per liter (mg/l), but values of several times these amounts are not uncommon in systems containing relatively abundant quantities of organic matter (e.g., peat).

In general, clays and other fine grained sediments normally tend to contain a greater proportion of organic matter than is usually present in sands and coarse grained deposits. This trend, in part, probably reflects differences in energies of depositional environments. Relatively low-energy, clay-depositing environments, sediments generally experience lesser degrees of winnowing and reworking than occur in relatively high energy, sand- and gravel-depositing environments. Also, organic matter may be less readily decomposed in clay and silt deposits than in sands, because of reduced aeration (and oxidation) within fine-grained sediments.

Average TOC values determined during 1982 detection monitoring of downgradient monitor wells GM-1, GM-2, and

GM-6 were 17, 7, and 10 mg/l, respectively, as opposed to an average of about 3 mg/l in the GM-0 background well (Table 1). In data from the recent water-quality assessment program (Table 2), average TOC values were 8.6, 4.4, and 6.5 mg/l in the three downgradient wells and 1.3 mg/l in the background well; the average TOC level for Mercury Pond fluids was about 4 mg/l. All of the recorded TOC values are thought to be within a natural range.

Based on the analytical results presented in Table 2, the Mercury Pond does not appear to represent a likely source for higher-than-background TOC levels in downgradient wells, because fluids contained in this impoundment are characterized by appreciably lower TOC values than are typically found in groundwater sampled hydraulically downgradient from the Mercury Pond facility. Because PPG has not stored or disposed of any synthetic organic compounds in the Mercury Pond area (as evidenced by low TOX values) it is reasonable to hypothesize that differences in TOC levels between the background and the downgradient wells may reflect natural variations in groundwater quality that result from differences in lithology; i.e., downgradient wells are installed into clay- and silt-rich deposits, whereas, the background well is constructed in predominantly sand and gravel deposits. Also, downgradient monitor wells are located in relatively close proximity to valley wall bedrock deposits and associated layers of coal, a concentrated TOC source material; and coal fragments were noted in several of the lithologic logs prepared from downgradient well borings.

DISCUSSION OF SPECIFIC CONDUCTANCE ANALYSES

Specific conductance (SC) is a measure of a fluid's ability to conduct an electrical current (expressed in micro-mhos per centimeter), and is an indication of the ion concentration in a solution; as the ion concentration increases SC also increases. Inspection of averaged 1982 monitoring data presented in Table 1 indicates that significantly higher SC levels in downgradient monitor wells primarily result from higher-than-background levels of sodium, and to a lesser extent, chloride, magnesium, and iron. Bicarbonate also appears to be elevated in downgradient wells; however, this ion is less closely related to SC (Hem, 1970), and it is uncertain how bicarbonate may influence observed SC trends.

Natural sources of sodium in groundwater include sodium-bearing minerals like plagioclase feldspar and halite (which also represents a main chloride source). However, sodium levels in downgradient wells are more than an order-of-magnitude higher than found in the GM-0 background well, and it seems unlikely that a difference of this magnitude can be totally attributed to natural variations in groundwater quality between the background and downgradient monitoring areas.

Comparisons of analytical data presented in Table 2 also tend to rule out the Mercury Pond as a probable source for relatively high sodium and chloride levels in downgradient wells. If the Mercury Pond had been loosing fluids to the underlying aquifer system, particularly in an area where the aquifer is not very extensive, it is expected that groundwater receiving this seepage would begin to acquire quality traits reflective of the effluent's composition. As can be seen in Table 2, groundwater obtained from downgradient monitor wells has a vastly different chemical make-up from that found in Mercury Pond fluids. In particular:

- Downgradient monitor wells exhibit a near-neutral pH (7.0 to 7.3), whereas, fluids in the Mercury Pond have a very high pH (11.6 to 12.0)

- Dissolved mercury is present at appreciable levels in pond fluids (about 350 ug/l), but is essentially absent in downgradient monitor wells

- Mercury Pond brine contains high concentrations of sodium and chloride with Na/Cl ratios ranging from 0.72 to 0.76 (typical of a NaCl source), whereas, groundwater in downgradient wells has substantially greater proportions of sodium relative to chloride, with Na/Cl ratios ranging from 1.6 to 6.8.

The latter observation is especially important in discounting the Mercury Pond as a probable cause of water-quality differences in downgradient wells. Because natural source materials for sodium and chloride are not believed to be abundant in the alluvial aquifer system, it is reasonable to expect that Na/Cl ratios in groundwater receiving brine-type effluents would gradually become similar to that of the brine, even though ion concentrations may be substantially lower; i.e., brine effluent entering the system would probably have a significant enough contribution to the overall sodium and chloride levels that it would tend to control Na/Cl ratios.

The above reasoning would also seem to rule out past brine storage practices (i.e., 1943 until about 1960) as a likely source of relatively high sodium and chloride levels in downgradient wells. However, it is important to keep in mind that seepage from the old facility would have been eliminated more than 20 years ago (when the facility was initially closed), and it is possible that natural mechanisms operating within the subsurface system have acted to change the relative proportions of sodium and chloride ions that were introduced via brine seepage.

One possible explanation for how such a change might occur relates to differences in the retardation factors for chloride and sodium. The chloride ion, owing to its small size and negative charge, behaves very conservatively within the groundwater system, i.e., it is not readily removed from solution via sorption or precipitation, and is potentially very mobile (relative to other ions). Sodium is also fairly conservative, compared to other cations, but is considerably more subject to attentuation than the chloride ion. This is largely because sodium is adsorbed onto mineral surfaces having appreciable cation exchange capacities (e.g., clays)(Hem, 1970), especially at high concentrations where the sodium ion may tend to replace other adsorbed cations (e.g., calcium and magnesium). Consequently, it is reasonable to assume that a clay-rich system receiving brine effluents would tend to preferentially retain sodium, relative to chloride. It also follows that once the source of effluent is eliminated, chloride ions should be flushed from the system more readily than the adsorbed sodium ions.

A related, possible explanation for why sodium is now back into solution (i.e., a dissolved groundwater constituent) at higher-than-background levels is that dissolved sodium ions, having been preferentially adsorbed onto clays when introduced at high levels (i.e., during brine seepage), have dropped in concentration (due to source elimination) to a point where adsorbed sodium is now being replaced by more strongly attracted cations. This condition is roughly analogous to the operation of a water softener, where the adsorbing medium, having been flushed with a high sodium solution to replace calcium and other cations, begins to release sodium as hardness-contributing parameters are adsorbed back on to the medium.

CLOSING COMMENTS

Based on Geraghty & Miller, Inc.'s inspection of available water-quality and other subsurface data, it does not appear that waste-holding practices at the Mercury Pond facility are responsible for the statistically higher TOC and SC levels observed in downgradient monitor wells. This interpretation is largely based on the overall degree of chemical dissimilarity between Mercury Pond fluids and groundwater in downgradient wells, as well as the lithologic differences that are known to exist between the background and downgradient monitoring areas.

It is believed that higher-than-background TOC values are related to lithologic differences, and significantly higher SC values may be a result of brine seepage that occurred during past (and discontinued) practices. Of particular importance is the fact that high pH and dissolved mercury, two of the main waste-specific parameters necessitating detection monitoring at the Mercury Pond facility, are not observed in groundwater sampled downgradient from this impoundment.

Respectively submitted,

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REFERENCES

Geraghty & Miller, Inc., April 1981, Evaluation of Ground-water Quality Impacts at the PPG Mercury Pond, Natrium, West Virginia.

Hem, John D., 1970. Study and Interpretation of the Chemical Characteristics of Natural Water: U.S. Geological Survey Water-Supply Paper 1473, U.S. Government Printing Office, Washington, D.C.

Krauskopf, Konrad B., 1967. Introduction to Geochemistry: McGraw-Hill Book Company, New York.

EVALUATION OF GROUND-WATER QUALITY IMPACTS AT THE PPG MERCURY POND, NATRIUM, WEST VIRGINIA

Final Report

Prepared For:

PPG INDUSTRIES
Natrium, West Virginia

By:

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April, 1981

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INTRODUCTION

In September 1980, Geraghty & Miller, Inc., was retained by PPG Industries, Inc. (PPG) to assess the impact of a mercury pond at the Natrium, West Virginia, plant on ground-water quality and to develop a monitoring program to comply with federal hazardous-waste regulations. To meet the study objectives, an exploratory drilling program was undertaken at the mercury pond to collect data on geology, depth and location of ground water, direction of ground-water movement, and ground-water quality. Available published and unpublished data on regional geology and hydrology were collected for evaluation.

Contained within this report are the findings of the hydrogeologic study made at the mercury pond. Also included are recommendations for ground-water monitoring to be carried out by PPG in compliance with hazardous-waste regulations promulgated by the U.S. Environmental Protection Agency.

Operational History

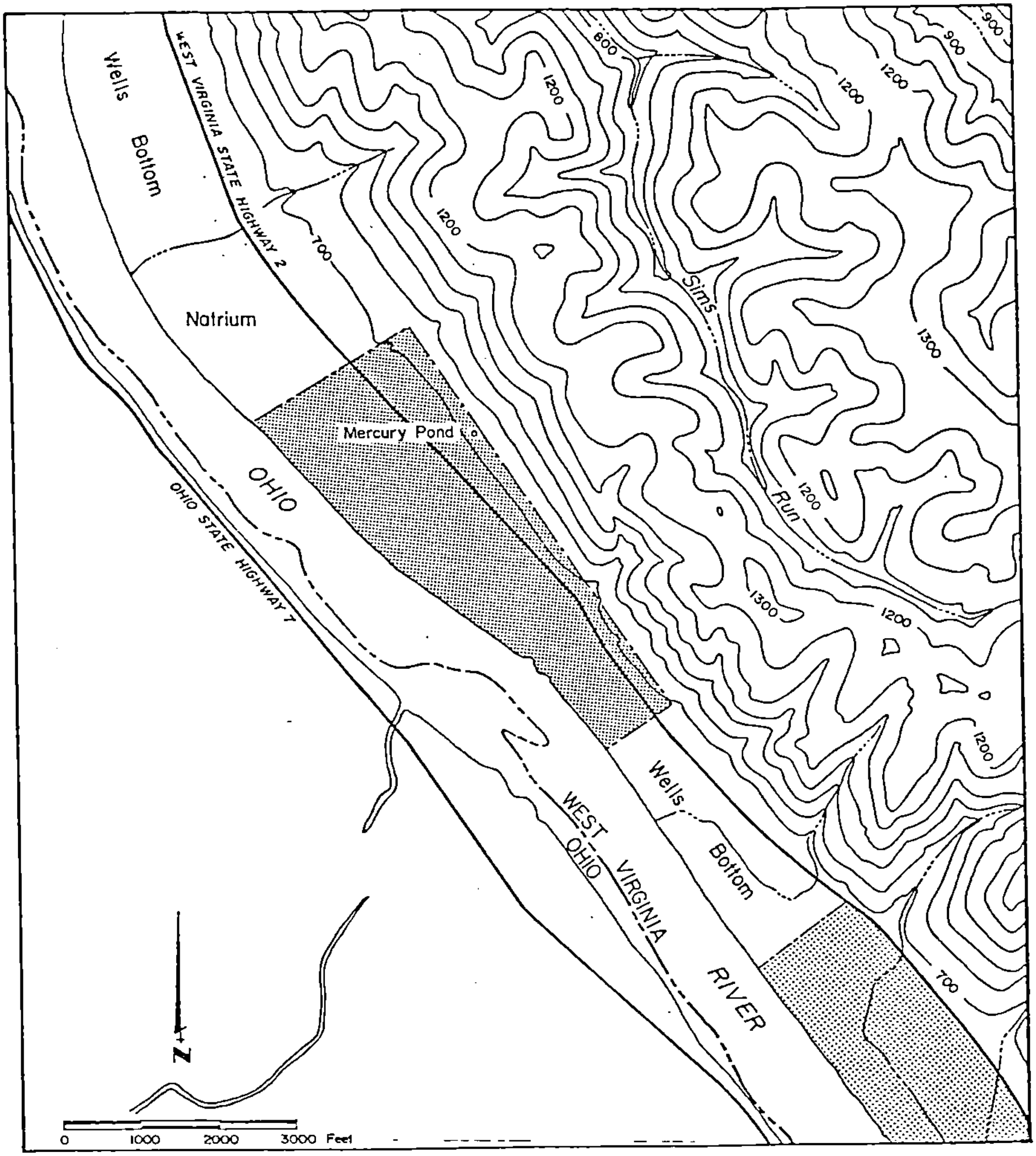
The PPG plant at Natrium makes a wide variety of predominantly inorganic compounds. Chlorine used by the plant is produced on the plant property through a solution mining operation of sodium chloride.

For several years, the facility that is now the mercury pond was used as a storage basin for sodium chloride brine produced from wells. The facility was concrete lined and used until about 1960. In the early 1970's, PPG equipped the basin with a plastic liner to handle waste flow from the plant's mercury cell, chlorine circuit. The mixed mercury waste entering the pond is precipitated as mercury sulfide and the resultant clarified liquid effluent is treated via carbon filtration prior to discharge in the Ohio River. The pond is periodically cleaned of mercury sulfide and the liner has been replaced once.

Location and Physical Setting

The PPG plant at Natrium, West Virginia, lies along the Ohio River approximately 30 miles (mi) south of Wheeling and 6 mi north of New Martinsville. The plant takes up the northern half of an area known as Wells Bottom, a part of the Ohio River floodplain that is 5 mi long and up to 0.4 mi wide (see Figure 1).

Wells Bottom is one of a series of alluvial features that fringe the Ohio River on alternate sides throughout its length. The bottom is composed of several recent river terraces cut into the flanks of an older and higher fluvio-glacial terrace.



EXPLANATION

PPG INDUSTRIES, INC. MAIN PRODUCTION FACILITY

MOBAY CHEMICAL CO.

Figure 1. Location of PPG Plant Site and Mercury Pond, Natrium, West Virginia.

The plant site rises in three steps from the river toward highlands on the east. Elevation at the plant site varies from about 620 feet (ft) at the river level to about 700 ft at the base of the highlands. The terraces rise rather abruptly but terrace tops are generally broad and flat. The high hills immediately east rise to an elevation of 1,300 ft within one mile.

REGIONAL SETTING

Geology

The Ohio River at Natrium is entrenched in Paleozoic sedimentary strata composed of sandstone, siltstone, clay, mudstone, marine limestone, fresh-water limestone, marly shale, and coal. Overlying this bedrock are Pleistocene alluvial deposits. The alluvium may be up to 120 ft thick beneath the higher Ohio River terraces and is composed of bedrock fragments of local origin and quartz, quartzite, granite, and chert which were transported south from continental glaciers. Along the edges of the valley, the river terraces may be capped by colluvial material (rock fragments) derived from bedrock highlands.

The soils along Wells Bottom at PPG are classified by the Soil Conservation Service as Made Land (includes filled and reworked material) and Brookside silt loam series. The area around the mercury pond is characterized by Brookside soils that are deep and well drained. This soil is underlain by colluvial material derived from limestone, acid sandstone, and alkaline and acid shale (SCS, 1960). Stone fragments are common throughout the profile.

Permeability of the Brookside series ranges from 5.6×10^{-4} cm/sec (0.8 in/hr) to 3.5×10^{-3} cm/sec (5.0 in/hr)(SCS, 1960). The subsoil is yellowish brown to grayish brown and ranges in acidity from strongly acid to slightly acid. The areas of less acid soil occur mostly at the base of steeper slopes.

Water Resources

Precipitation is ample and fairly well distributed throughout the year with maximum precipitation occurring during the summer and minimum in the fall (September to November). Total annual precipitation in the Ohio Valley increases from north to south. Normal precipitation for Wheeling is 38 inches (in) and for New Martinsville, 44 in. There is no available data concerning precipitation for Natrium, but it is assumed that average precipitation at the plant site is 40 to 42 in per year.

The plant site lies along the Ohio River. River level is controlled at an elevation of approximately 623 ft by a dam to the south of the plant. The plant site naturally drains to the river via intermittent streams and overland flow. There is no channelized flow of surface water near the mercury pond except for drainage ditches along the pond access road. Table 1 gives a summary of Ohio River water-quality at Newell and Ravenswood, West Virginia, and for Fishing Creek at New Martinsville.

Ground-Water Conditions

Ground water is found in several aquifers in the vicinity of PPG. The most important of these is the alluvial material of the Ohio River valley. Yields from wells in these sediments typically are 100 to 500 gallons per minute (gpm). The Paleozoic bedrock generally is capable of producing only small quantities of water, and quality is usually poor.

Water in the alluvium of the Ohio River valley aquifer is of generally good quality with a total dissolved solids content of around 500 mg/l or less. The water may be locally hard and sulfurous. PPG is presently pumping about 5,000 gpm from wells constructed into the alluvium.

TABLE 5. QUALITY OF SURFACE WATER IN THE OHIO RIVER VALLEY NEAR NATRIUM, WEST VIRGINIA (All analyses are expressed in mg/l, except pH and specific conductance, which are expressed in standard units).

PARAMETER	Ohio River at Newell, WVa. (1960 mean)	Ohio River at Ravenwood, WVa. (1960 mean)	Fishing Creek at New Martinsville, WVa. (10/1/60)
Specific Conductance	360	413	304
Total Dissolved Solids	226	255	164
pH	-	-	7.4
Calcium	32	39	26
Sodium	19	24	21
Magnesium	9.2	9.6	6.1
Potassium	2.2	2.3	2.2
Total Iron	-	-	0.3
Manganese	-	-	0.28
Chloride	15	31	40
Bicarbonate	14	36	75
Sulfate	122	111	23
Nitrate	3.9	3.9	0.2
Fluoride	0.3	0.3	0.2
Silica	7.4	6.9	3.1
Total Hardness as $CaCO_3$	225	245	118

SITE INVESTIGATION

Soil Borings and Monitor-Well Installation

The field data-collection program was conducted during October and early November 1980. Pittsburgh Testing Laboratory, using a CME B-61 drill rig, installed boreholes to depths ranging between 45 to 100 ft at the locations shown on Figure 2. A 3-3/8-in inside diameter hollow-stem auger was used to drill through the unconsolidated material above bedrock. A 2-in outside diameter split-spoon sampler was driven ahead of the auger bit to collect soil samples. Split-spoon samples were taken at 5-ft intervals in holes GM-1, GM-2, GM-3, and GM-6. In GM-4, split-spoon samples were collected continuously from land surface to approximately 46 ft and at 5-ft intervals thereafter to 80 ft. Due to proximity to other boreholes, a limited sampling program was undertaken at GM-5 and GM-7. A 3-in outside diameter thin-walled Shelby tube sampler was used to collect undisturbed soil samples at 5 to 9 ft in GM-7, at 11 to 13 ft in GM-2, and at 27 to 29 ft in GM-3.

Samples collected using the split-spoon sampler were visually identified and logged in the field (see Appendix A for lithologic logs of all boreholes). Selected samples were analyzed in the laboratory for grain-size distribution (see Appendix B). The Shelby tube samples collected in GM-2

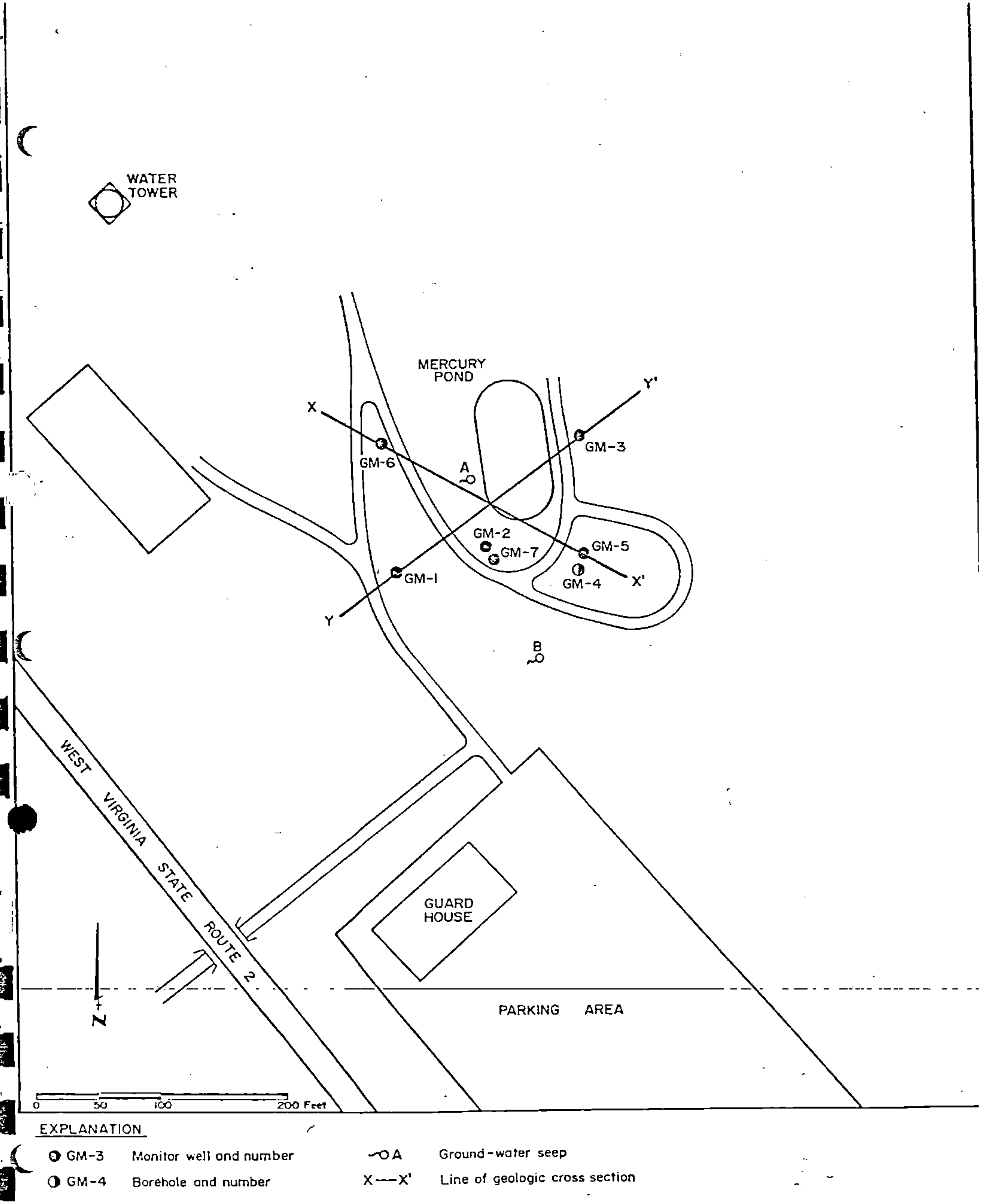


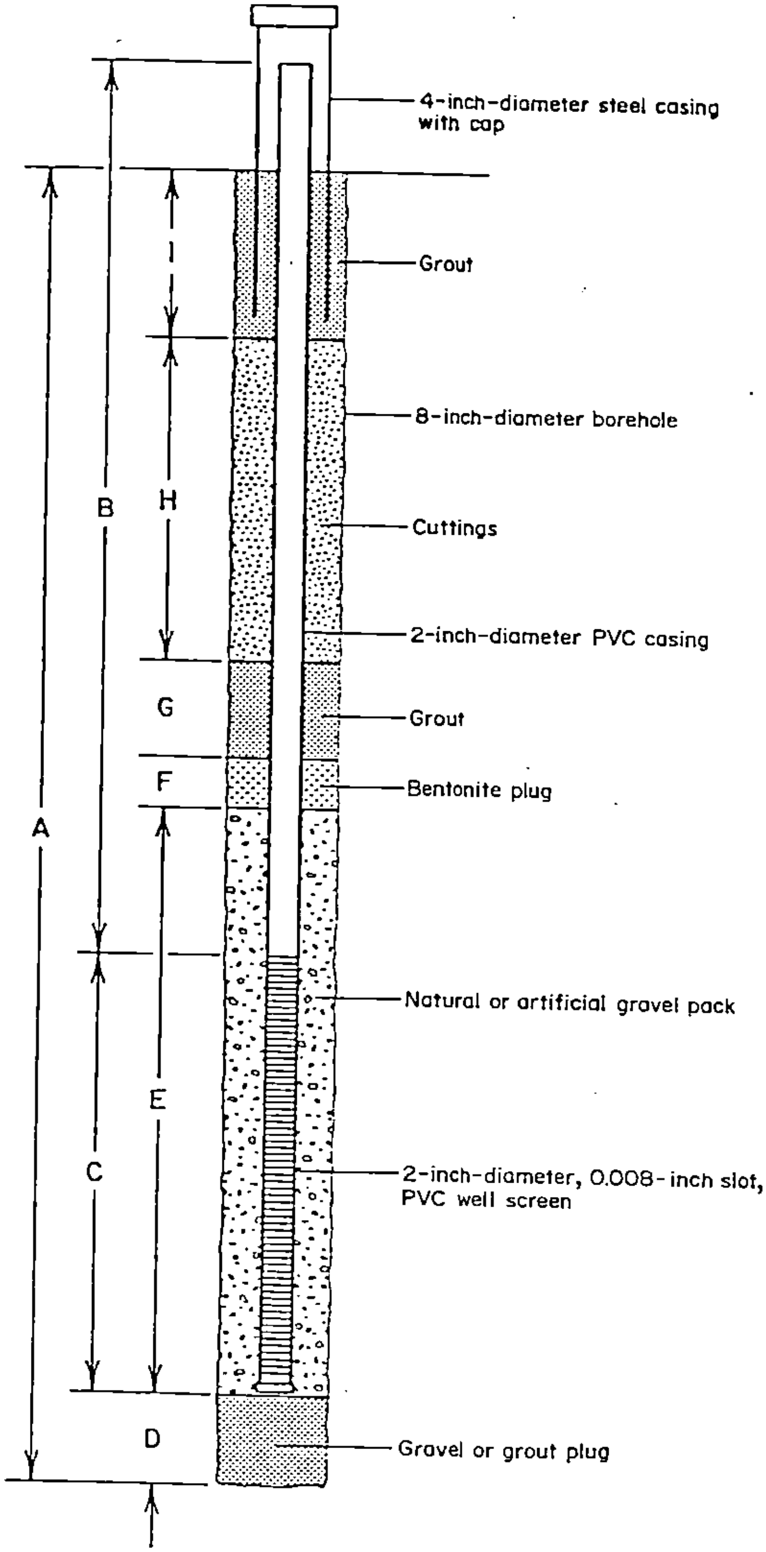
Figure 2. Location of Monitor Wells, Soil Borings, Seeps, and Geologic Cross Sections at PPG, Natrium, West Virginia.

and GM-3 were tested in the laboratory to determine hydraulic conductivity, and those collected in GM-7 were used to prepare water extracts for the purpose of water-quality analyses.

Monitor wells were installed in all boreholes (except GM-4) using 2-in-diameter PVC casing and 0.008-in slot PVC well screen. Gravel was placed in the annulus between the screen and borehole to at least 5 ft above the top of the screen. A bentonite plug was placed on top of the gravel and a combination of Type I Portland cement and cuttings were used to seal the annular space to land surface. A 4-in steel protective casing was installed around the PVC casing above land surface. A diagram of the well construction is found in Figure 3.

Water-Quality Sampling

Following development of each monitor well to remove sediment, water samples were collected for the purpose of analysis to determine quality. Using a PVC bailer, samples were withdrawn from wells GM-1, GM-2, and GM-6. In addition, water samples were collected from the mercury pond prior to release to the carbon beds, and from one of the PPG water-supply wells. There was insufficient water in wells GM-3, GM-5, and GM-7 to permit sampling. The samples were analyzed for selected parameters by the PPG laboratory.



DIMENSION, IN FEET	WELL NUMBER					
	GM-1	GM-2	GM-3	GM-5	GM-6	GM-7
A	96	99.75	54.75	45	81	54
B	89	92	23.25	37.3	67.9	47.3
C	10	10	10	10	10	10
D	0.6	1.0	24.75	1.0	6.2	0
E	32.4	31.25	15	14.25	21.8	27
F	1	1	1	1	1	1
G	10	16.5	5	9.75	12.5	9
H	48	47	7	16.5	37.5	15
I	4	3	2	2.5	2	2

Figure 3. Monitor-Well Construction Diagram.

Water samples were also collected from two seeps located below the mercury pond. Only a limited set of analyses were made on these samples.

During drilling several highly moist zones were encountered. At many locations, there was insufficient water to permit extraction via wells. In order to determine water quality in these areas, the Shelby tube sampler was used to collect soil samples that were later subjected to leaching with distilled water to allow an approximation of the quality of water in this zone. Two Shelby tube samples were collected in boring GM-7 and leached by the PPG laboratory.

SITE HYDROGEOLOGIC CONDITIONS

Topography and Drainage

The mercury pond is situated on a small and fairly level area which may be the remnant of an old river terrace. The terrace slopes very rapidly to the west below the pond and rises above the pond to the northeast to Wayne Ridge. Maximum relief of the site between GM-1 at the base of the terrace southwest of the pond to GM-3 located just northeast of the pond is 28.7 ft.

Surface drainage at the site is primarily via intermittent streams which arise east of the pond and flow to the northeast and southwest (see Figure 1). These streams completely by-pass the pond area. Several seeps of ground water occur along the face of the terrace on which the mercury pond sits. The seeps are not sufficiently large to permit formation of channels.

Lithologic Characteristics

All seven boreholes constructed at the mercury pond encountered a heterogeneous mixture of clay, silt, sand, gravel, and weathered rock fragments overlying shaley mudstone or siltstone and sandstone bedrock. Depth to bedrock varied from approximately 50 to 100 ft and changes in bedrock elevation range from 669 ft at GM-3 to less than 595 ft at GM-1.

The diverse mixture of sediments encountered during drilling is representative of colluvial or detrital material deposited by landslides and slumping of material originating on the upland east of the pond site. Rock fragments are common throughout the sedimentary sequence.

Figures 4 and 5 present two geologic cross sections of the site as determined from boring logs. As shown in the cross sections, there is a great deal of clay present beneath the pond site. The clay layers appear to be continuous rather than lenses and range from 8 to 28 ft in thickness. Weathered rock fragments and minor amounts of gravel and

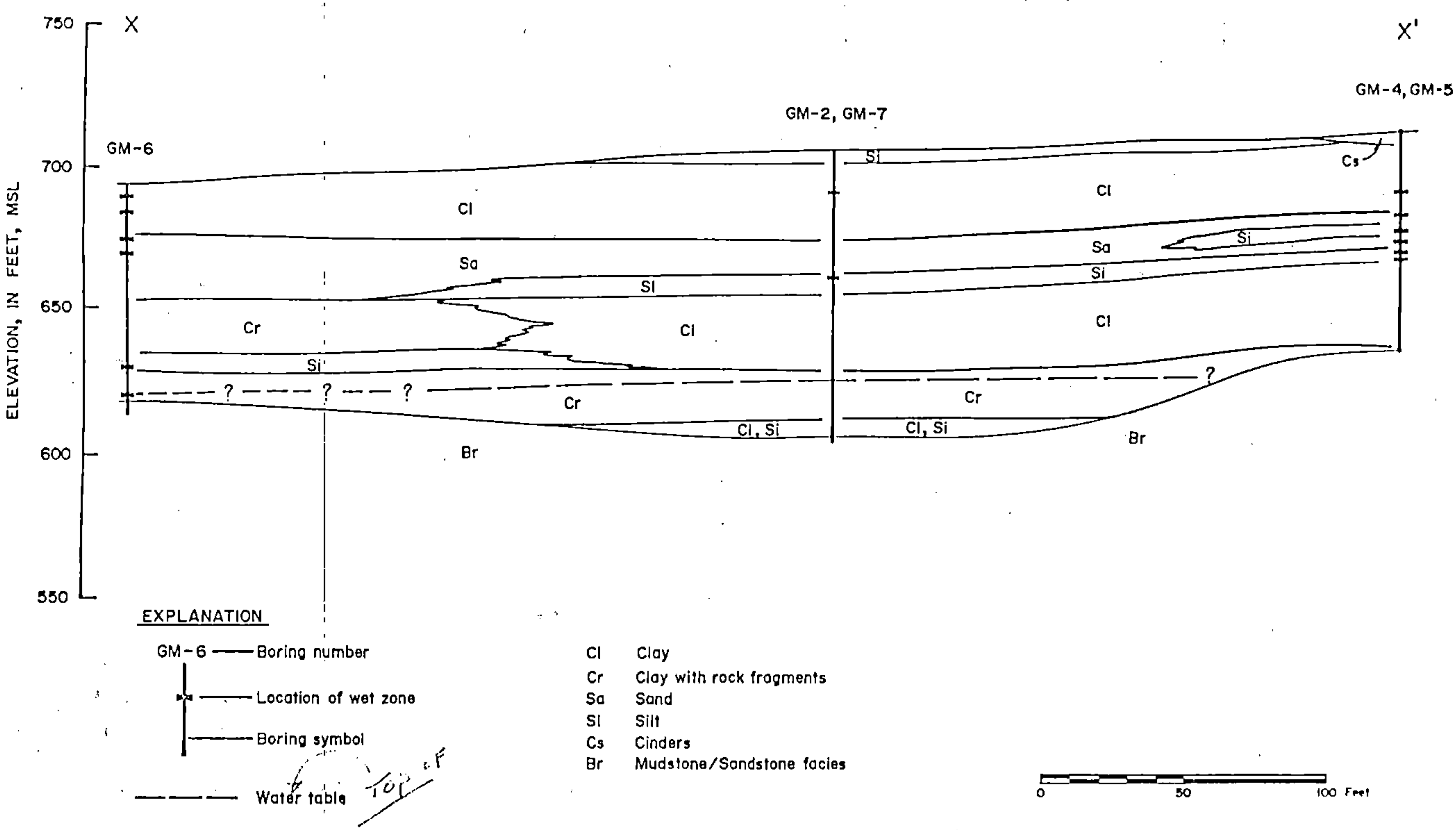


Figure 4. Geologic Cross Section (X-X'), PPG, Natrium, West Virginia.

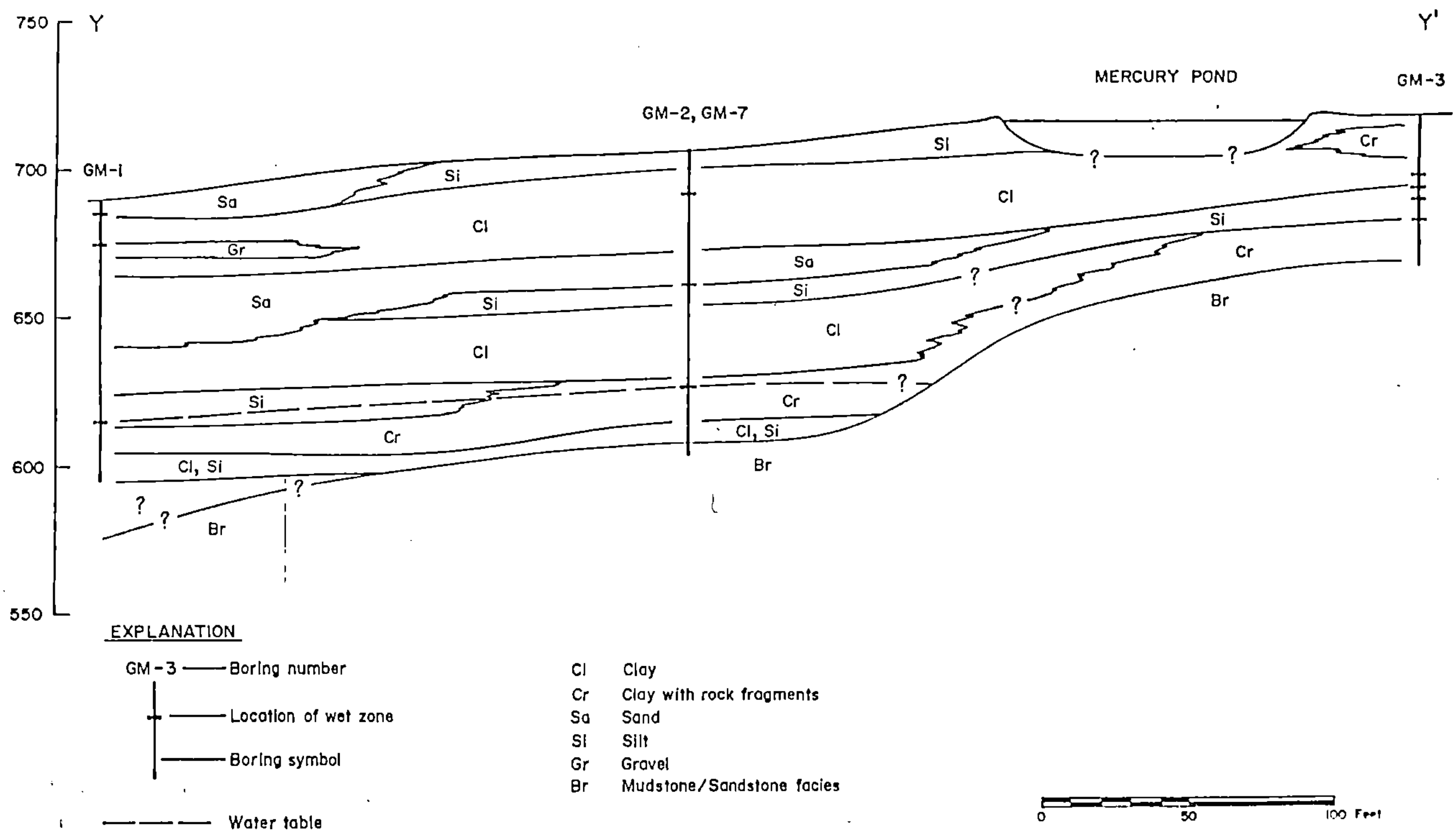


Figure 5. Geologic Cross Section (Y-Y'), PPG, Natrium, West Virginia.

silt or sand are found throughout the clay layers.

A clean, generally well sorted and dry brown sand found at most locations beneath the upper clay, generally at 20 to 30 ft below land surface, ranges from 10 to 25 ft in thickness. This unit, although occasionally moist, was never found to be thoroughly saturated with water. Underlying the sand layer is a moist to wet silt unit, 4 to 12 ft in thickness. A thick clay layer is then found above a silt unit which rests on a weathered bedrock surface. The bedrock surface rises rapidly beneath the mercury pond. The bedrock, which is composed of mudstone or fine-grained sandstone, is highly weathered at the interface.

Ground-Water Flow

Two zones of ground water were encountered during drilling around the mercury pond: (1) a discontinuous perched water table and (2) the deeper Ohio River valley alluvial aquifer. Perched-water conditions were encountered at various depths to about 30 ft below land surface in small silt and sand layers (Table 2). These wet zones were present in all boreholes but during the fall of 1980 there was not sufficient water to be collected in the shallow wells. The perched water table may yield water to wells during spring and early summer in response to increased recharge of precipitation in the fall and winter months. (Monitor wells

TABLE 2. ELEVATION AND LITHOLOGIC DESCRIPTION OF PERCHED WATER ZONES

Well Number	Elevation of Perched Water Zones (ft)	Generalized Description
GM1	685	Sand/clay interface
	675	Clay/gravel interface
GM2	692	Clay
	662	Sand/silt interface
GM3	698	Clay
	694	Silt
	690	Silt
	683	Silt/clay and rock fragments interface
GM4/5	694	Clay and gravel
	685	Sand
	680	Silt
	676	Sand
	672	Silt
	669	Silt
GM6	689	Clay
	684	Clay
	674	Sand
	669	Sand

were installed at GM-3, GM-5, and GM-7 to monitor the perched water table.) Several seeps along the face of the terrace below the mercury pond discharge from the perched water zone. Figure 6 shows the elevation of the lowermost perched conditions found in boreholes and maps an inferred flow system. Ground-water flow in this zone is to the west and toward the Ohio River.

Approximately 50 ft beneath the perched water table is the semi-confined Ohio River valley alluvial aquifer. The aquifer is found in silt and fine sand at the bedrock interface. The aquifer was not encountered above the bedrock surface east of the pond. Bedrock here rises rapidly from less than 595 ft in GM-1 to 668 ft in GM-3.

Figure 7 is a water-level contour map of the alluvial aquifer as determined from water levels in the deep boreholes (GM-1, GM-2, and GM-6). Ground-water movement is toward the Ohio River. It was found that the water level in well GM-1 (615 ft) is lower than the level of the Ohio River (623 ft). Ground-water pumpage from wells at the PPG plant site is believed to be the cause of lowering the potentiometric level below the river level.

Vertical hydraulic conductivity of the clay and saturated silt beneath the mercury pond was determined in the laboratory. Water movement is extremely slow in the clays

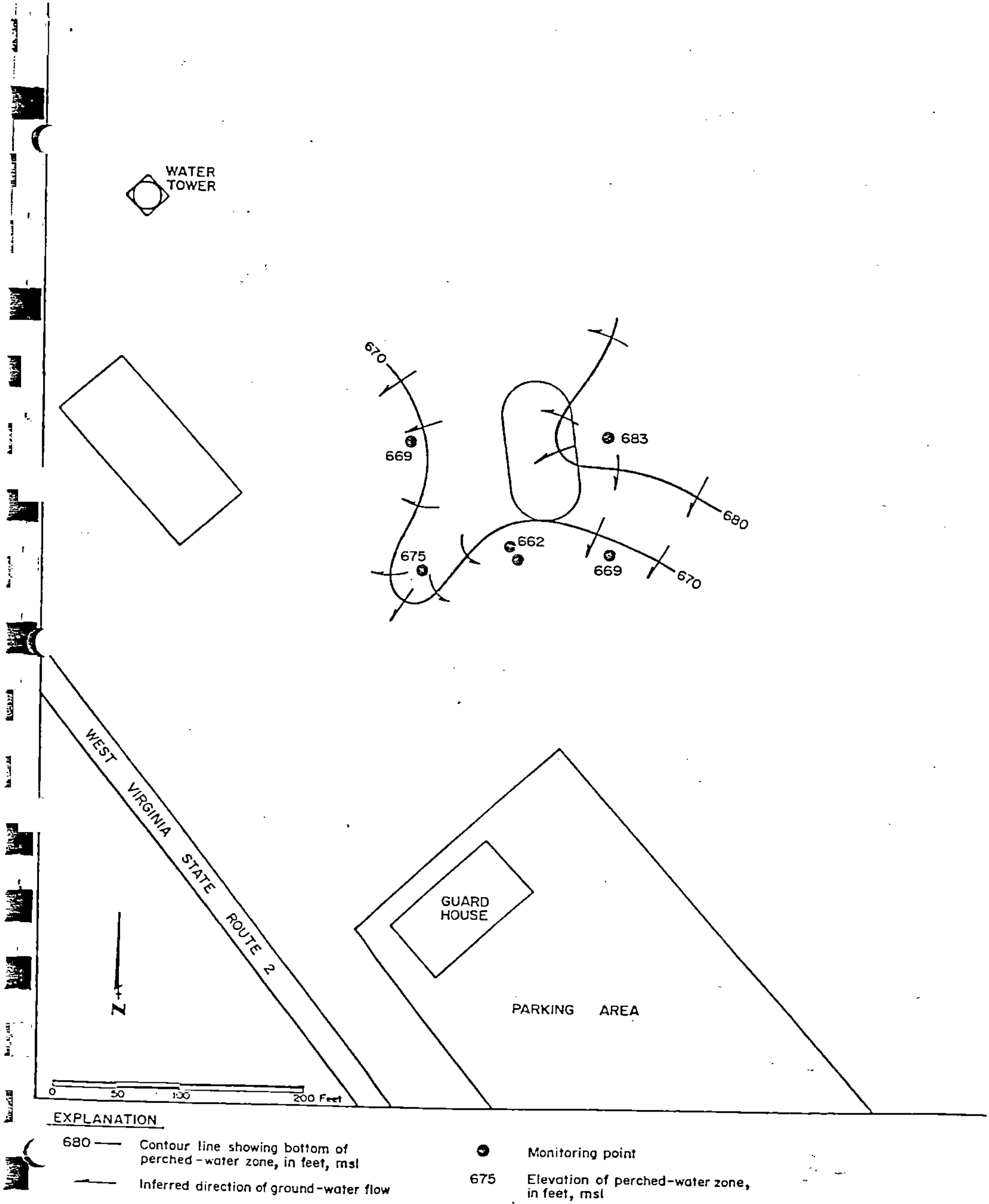
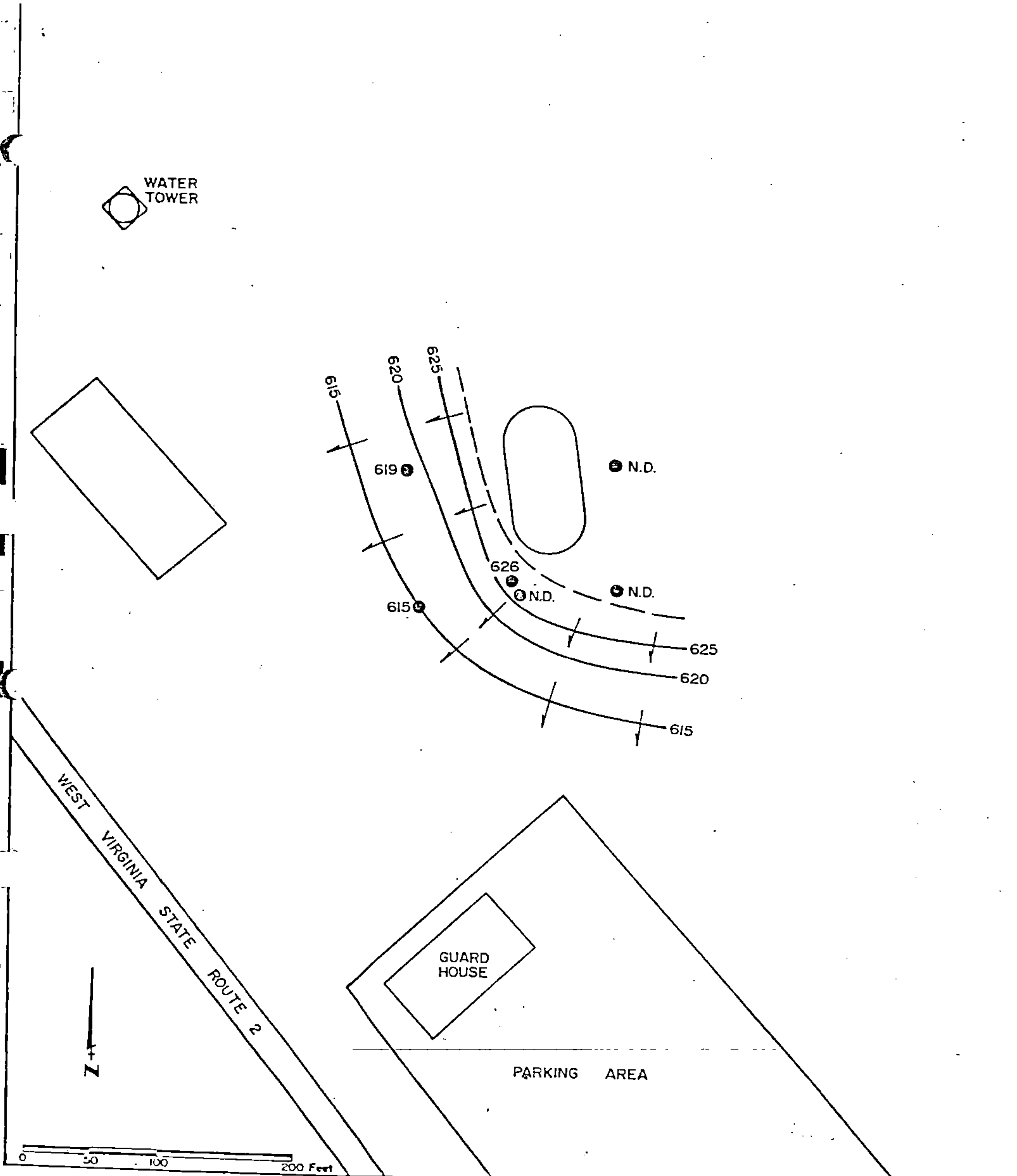


Figure 6. Elevation of the Bottom of the Perched-Water Zone, PPG, Natrium, West Virginia.



EXPLANATION

620 ——	Water-level contour, in feet, msl	●	Monitor well
— — —	Approximate boundary of surfical aquifer	626	Water-level elevation, in feet, msl
——	Direction of ground-water flow	N.D.	Not detected

Figure 7. Water-level Contour Map of the Ohio River Alluvial Aquifer, PPG, Natrium, West Virginia.

(3.0×10^{-8} cm/sec) and slow in the silts (1.5×10^{-6} cm/sec) (Table 3). The horizontal hydraulic conductivities could not be determined, but in sediments of this type they are typically about one order of magnitude greater. Several samples collected from GM-2 and GM-7 were tested to determine cation-exchange capacities of the sediments. The analyses are presented in Table 4 and exhibit relatively low exchange capacities, 10.39 meq/100 gm and less.

Ground-Water Quality

Water samples were collected from both the perched-water zone and the Ohio River alluvial aquifer to determine natural quality conditions and the present and/or past quality effects of the mercury pond. The results of the water-quality analyses are presented in Tables 5 and 6. Table 5 contains the analyses of samples collected from wells GM-1, GM-2, and GM-6; a PPG water-supply well located northwest of the mercury pond; and overflow from the mercury pond. Table 6 presents the results of leach tests run on the soil samples collected from perched-water zone and of two seeps along the face of the terrace.

This series of water-quality samples was directed primarily at inorganic water-quality parameters, including major cations and anions and selected trace elements included in the EPA drinking water standards. It was decided to

TABLE 3. VERTICAL HYDRAULIC CONDUCTIVITIES OF SHELBY TUBE SAMPLES

Well Number	Depth Interval (ft)	Hydraulic Conductivity (cm/sec)	(ft/day)	Sample Description
*GM-2	11-13	3.0×10^{-8}	8.5×10^{-5}	Clay, tight, plastic, brown and orange-tan, with weathered rock fragments, micaceous
GM-3	27-29	1.5×10^{-6}	4.2×10^{-3}	Silt, clayey, gray-green with brown mottles, wet

*sieve analyses also available for this sample

TABLE 4. CATION EXCHANGE CAPACITIES OF SELECTED LITHOLOGIC SAMPLES

Well Number	Depth Interval (ft)	Cation Exchange Capacity (meq/100 gm)	Sample Description
GM-2	13 - 14.5	5.04	Clay, tight, plastic, brown and orange tan; with weathered rock fragments
GM-2	59.5 - 61	9.62	Clay, tight, plastic, red-brown; with weathered sandstone rock fragments
GM-2	99.5 - 101	10.39	Clay, brown, wet with rock fragments; mudstone bedrock in lower half of sample
GM-7	29.5 - 31	0.0	Sand, fine grained, silty, clean, dry, orange brown to tan
GM-7	46 - 47.5	4.74	Clay, soft, moist, red-brown; with weathered sandstone fragments

TABLE 5 ATER QUALITY ANALYSE , which are expressed in standard units)

(All analyses for parameters below are expressed mg/l, except color an ,

PARAMETERS	Sampling Points: GM-1	GM-2	GM-4	Pond Overflow To Carbon Bed	PPG Plant Well	Maximum Contaminants Levels *
Field Temp (°C)	14	14.5	14	-	-	
Field Specific Conductance (mhos/cm)	850	1,300	550	-	-	
Field pH	7.1	7.4	6.8	-	-	6.5 - 8.5
Total Dissolved Solids	532	1,117	338	32,200	340	500
Laboratory pH	7.9	7.5	7.9	11	7.2	6.5 - 8.5
Color (APHA)	15	10	5	0	0	15
Sodium	128	168	51.9	8,764	8.9	
Calcium	83.9	140	84.7	16.2	111	
Magnesium	28.5	24.2	10.6	1.1	10.4	
Manganese	0.12	2.3	0.012	<0.01	<0.005	0.05
Total Iron	<0.1	<0.1	<0.1	0.057	<0.1	0.3
Potassium	2.5	14.6	2.6	5.3	2.5	
Chloride	54	307	39	19,000	27	250
Sulfate	21	133	81	319	78	250
Nitrate as N	0.11	0.1	0.11	-	3.35	10
Alkalinity as $CaCO_3$	564	319	235	306	196	
Alkalinity as HCO_3	688	389	287	373	239	
Total Organic Carbon	60	690	9.0	-	5.0	
Arsenic	0.015	<0.005	<0.005	<0.005	<0.005	0.05
Barium	0.84	0.43	0.10	0.032	0.073	1
Cadmium	<0.005	<0.005	<0.005	<0.01	<0.005	0.01
Chromium (Total)	<0.1	<0.1	<0.1	<0.01	<0.1	0.05
Chromium (VI)	<0.01	<0.01	<0.01	<0.01	<0.01	
Copper	<0.1	<0.1	<0.1	<0.01	<0.1	1
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	0.05
Mercury	<0.0005	<0.0005	<0.0005	<0.019	<0.0005	0.002
Selenium	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Silver	<0.005	<0.005	<0.005	<0.01	<0.005	0.05
Zinc	<0.1	<0.1	<0.1	0.01	<0.1	
Fluoride	1.5	0.6	0.6	-	0.5	1.4 - 2.4

- No analysis made

* EPA Interim Primary or Secondary Drinking Water Standards

TABLE 6. SOIL LEACHATE AND WATER QUALITY ANALYSES
(All analyses for the parameters below are expressed in mg/l, except color and pH, which are expressed in standard units.)

PARAMETER	Soil Leachate GM-7 (5-7 ft) 1	Soil Leachate GM-7 (5-7 ft) 2	Soil Leachate GM-7 (7-9 ft) 1	Soil Leachate GM-7 (7-9 ft) 2	Spring A	Spring B
Total Dissolved Solids	2673	478	5043	1538	–	2040
pH	7.1	7.3	6.6	6.5	8.1	–
Color	15	83	0	0	–	–
Sodium	1050	219	1740	604	–	–
Calcium	11.0	9.8	29.7	11.4	–	–
Magnesium	<0.005	<0.005	8.4	0.5	–	–
Manganese	0.14	0.043	2.3	0.26	–	–
Total Iron	0.20	0.37	0.017	0.08	–	–
Potassium	1.8	1.8	3.0	1.6	–	–
Chloride	1535	328	2566	969	18176	669
Sulfate	71	47	67	44	390	275
Nitrate as N	0.3	1.0	0.4	0.3	–	–
Alkalinity as $CaCO_3$	59	49	21	33	–	–
Alkalinity as HCO_3	72	60	26	40	–	–
Total Organic Carbon	11.6	17.0	5.0	4.9	–	–
Arsenic	<0.005	<0.005	<0.005	<0.005	–	–
Barium	0.12	0.25	0.48	0.37	–	–
Cadmium	<0.02	<0.02	<0.02	<0.02	–	–
Chromium (Total)	<0.008	<0.008	<0.008	<0.008	–	–
Chromium (VI)	<0.01	<0.01	<0.01	<0.01	–	–
Copper	0.01	0.023	0.009	0.009	–	–
Lead	<0.005	<0.005	<0.005	<0.005	–	–
Mercury	<0.005	<0.005	<0.005	<0.005	<0.0002	<0.0002
Selenium	<0.005	<0.005	<0.005	<0.005	–	–
Silver	<0.005	<0.005	<0.005	<0.005	–	–
Zinc	0.25	0.15	0.31	0.046	–	–

– No analysis made

evaluate only inorganic parameters at this time because the major contaminants of concern from both the old brine operation and present mercury process are inorganic in nature.

Ohio River Alluvial Aquifer

The monitoring network installed at the mercury pond is designed to permit evaluation of the effect of the pond on ground-water quality by comparing water samples both hydraulically above and below the pond. Well GM-3 was located at a point presumed to be hydraulically upgradient and wells GM-1, GM-2, GM-6, and boring GM-4 were located hydraulically downgradient. Because of an abrupt change in elevation of the bedrock beneath the pond, however, the upgradient well (GM-3) did not intercept a water table in the alluvium. Additionally, the water table was not found in the alluvium at GM-4 and is very thin at GM-6. The Ohio River alluvial aquifer could only be sampled at locations GM-1 and GM-2. Fortunately, both of the wells are downgradient from the pond, permitting a comparison with other ground water in the aquifer away from the pond area (the PPG plant well).

The quality of water in GM-1 and the PPG plant well are very similar in quality for all parameters tested. There is no apparent elevation of mercury or any other trace metals in GM-1 and in general these levels are below detection limits.

Except for a slightly elevated total dissolved solids level, the water at GM-1 is well within acceptable health standards.

The quality in GM-2 is elevated above both GM-1 and the PPG plant well. Potassium, chloride, TDS, and TOC are all significantly higher. Mercury and all other trace elements are below detection limits as was found in GM-1 and the PPG well. At this time, these conditions should not be construed to indicate contamination resulting from the brine pond or mercury pond. During drilling of this well, drilling water was used to stabilize the borehole. It is possible that this water was not completely removed before the well was sampled. Subsequent sampling is planned to investigate this possibility.

Perched-Water Zone

Monitor wells were installed into the perched-water zone at GM-3, GM-5, and GM-7; during the fall of 1980, only well GM-5 produced sufficient water for sampling purposes. In order to assess the quality of soil water in this zone, soil samples were collected from GM-7 and subjected to a leach process using distilled water at 7.0 pH. Limited water-quality analyses were also made on two seeps along the terrace.

There is a visible indication that the perched-water zone is contaminated below the pond. Vegetation along the face of the terrace is stressed and during dry periods a white salt crust is observed on the soil. The results of the water-quality analyses support the conclusion of contamination in the perched-water zone. Except in well GM-5, TDS, sodium, chloride, and sulfate levels are high in the perched-water zone. Several thousand mg/l of both TDS and chloride are present; both levels are far lower than that found in the mercury pond, however. Trace elements, including mercury, are not elevated in the perched zone.

The contaminants found in the perched-water zone are present in high concentrations in both the brine originally stored in the pond and the mercury effluent now stored there. Because of the absence of mercury in the perched-water zone and because the mercury pond is lined, it is theorized that the most likely source of the contaminated water was the old brine storage, and that the residual salts found in this study were deposited in the soil over 20 years ago. In many soil systems, salts are transported through the soil in pulses during rainfall or other high recharge events. This phenomenon has been seen near abandoned oil field brine storage ponds in alluvium along a river in Ohio (Pettyjohn, 1978). The data from Ohio indicates that it may take a very lone time to flush this contamination from the ground-water system.

RECOMMENDED RCRA GROUND-WATER MONITORING PROGRAM

The final design of the ground-water monitoring program at the mercury pond, including the number and location of monitor wells, the frequency of sampling, and the constituents to be analyzed for, is influenced by state and federal requirements. In order to comply with these regulations, an understanding of the May 19, 1980, hazardous-waste regulations (RCRA) applicable to owners and operators of hazardous-waste facilities is necessary.

The ground-water monitoring requirements under Subpart F of RCRA are written such that an owner/operator of a facility may utilize one of three possible ground-water monitoring programs. The fundamental program applies to a facility which is not assumed or known to be contaminating ground water. In most cases, this system would be utilized at new facilities or facilities under construction.

The second program applies to a facility which is assumed or known to be contaminating ground water. This alternate program would be oriented toward defining the extent of contamination and monitoring its further migration. The third program applies to a facility where a justification can be provided for a lesser degree of monitoring because the owner/operator can demonstrate a low potential for migration of hazardous-waste constituents from the facility via the uppermost aquifer to water-supply wells or surface water.

Based on the data collected during this hydrogeologic investigation, the situation at the mercury pond does not appear to rigorously fit any of the three programs suggested in the EPA regulations. At this time, however, the second program seems least applicable. Discussed briefly below, therefore, is more information on the two types of programs which may be applied.

The fundamental ground-water monitoring program sets the deadlines and requirements applicable to the installation of a ground-water monitoring system and procedures to be followed in the event water-quality samples indicate that ground water is being degraded. By November 19, 1981, PPG will be required to install monitoring wells. Monitoring wells must be installed hydraulically upgradient from the limit of the waste-management area to yield ground-water samples that are representative of background water-quality conditions in the uppermost aquifer near the facility. In addition, monitoring wells must be installed hydraulically downgradient from the limit of the waste management area at locations and depths which ensure that any "wastes" that migrate from the waste management area to the uppermost aquifer are immediately detected.

In addition to installing the monitoring-well system, PPG is required to prepare a ground-water quality assessment plan outline. The outline represents (in a preliminary scheme) the procedures that will be followed to assess the extent to which wastes have entered ground water in the event results of water sampling indicate a statistically significant difference between present and background water quality.

Finally, PPG must develop and have on file a ground-water sampling and analysis plan. This plan must include procedures and techniques for sample collection, sample preservation and shipment, analytical procedures and chain of custody control.

For a period of one year after PPG has installed the monitoring wells, they must be sampled regularly to establish background water quality. Samples must be taken every three months and analyzed for: (1) parameters characterizing the suitability of the ground water as a drinking water supply including arsenic, barium, cadium, chromium (hexavalent), fluoride, lead, mercury, nitrate, selenium, silver, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP silvex, radium, gross alpha, gross beta, turbidity, and coliform bacteria, (2) parameters establishing ground-water quality including chloride, iron, manganese, phenols, sodium, sulfate, and (3) parameters used as indicators of ground-water contamination including pH, specific conductance, total organic carbon, and total organic halogens. After the first year, all monitoring wells must be sampled and the samples analyzed with the following frequencies: (1) parameters used to establish ground-water quality are sampled and analyzed annually, and (2) parameters used as indicators of ground-water contamination are sampled and analyzed semi-annually.

PPG must compare the results of the indicator parameter analyses with the background levels computed during the first year of monitoring and determine, by use of the Student's t-test, if a significant difference exists (at the 0.01 confidence interval). In addition, water-level readings must be taken to determine if the hydraulic gradient in the area has changed.

An alternative monitoring scheme is available if PPG can demonstrate that the mercury pond has a low potential to cause migration of contaminants; a lesser degree of monitoring may be used. The modified system could consist of fewer monitoring wells, less frequent sampling, analysis of fewer chemical parameters, or all of the above. To be utilized, the demonstration of a low potential for migration of contaminants must be certified by a qualified geologist or geotechnical engineer and must be in writing and kept on file at the facility.

Guidance for determining which monitoring system is most applicable to PPG is not stated in the regulations, nor has it been provided in guidance documents of the U.S. EPA. Several policy decisions and technical problems are left unresolved making it extremely difficult to develop a monitoring plan that is assured of satisfying both the State of West Virginia and the U. S. EPA. In an effort to resolve this problem and to gain some perspective from the state and the EPA regarding interpretation of the ground-water monitoring requirements, both state and federal officials were contacted. State officials indicate that each case would be handled on an individual basis; the federal contact at EPA Region III, however, suggests a strict interpretation of federal regulations, with no deviations, for compliance with and acceptance of RCRA ground-water monitoring plans. Although a cooperative work agreement has been drawn up between West Virginia Department of Natural Resources and EPA Region III, the agreement has not been implemented and PPG will probably have to work with each group separately.

Based on all of the foregoing, it is recommended that PPG institute the fundamental ground-water monitoring previously outlined for the Ohio River alluvial aquifer only. The PPG well should be considered the background well for the alluvial aquifer and wells GM-1, GM-2, and GM-6 will be down-gradient monitoring points.

Table 7 summarizes the sample frequency for all the parameters that PPG must analyze. Samples should be collected by a trained PPG employee. The water-quality analyses may be made by PPG if their lab has been approved by EPA, but otherwise should be made by an independent laboratory.

Additionally, it is recommended that an abbreviated sampling program be undertaken for the perched-water zone. This monitoring is not necessary for RCRA compliance but will provide PPG with a better understanding of movement of the remant contamination from the old brine-storage pond. Table 8 summarizes the sampling program for the perched-water zone.

A detailed sampling and analysis plan should be prepared and a ground-water assessment plan outline should be developed. Both must be present at the PPG site when sampling begins.

Respectfully submitted,

William E. Thompson
Senior Scientist

TABLE 7. MINIMAL SAMPLE COLLECTION AND ANALYSIS TO BE PERFORMED FOR RCRA COMPLIANCE

A. First Year

PARAMETER	PPG Water-Supply Well	GM-1, GM-2, GM-6
pH	4 replicates each quarter	quarterly
Specific Conductance	4 replicates each quarter	quarterly
Total Organic Carbon	4 replicates each quarter	quarterly
Total Organic Halogen	4 replicates each quarter	quarterly
Chloride	quarterly	quarterly
Iron	quarterly	quarterly
Manganese	quarterly	quarterly
Phenols	quarterly	quarterly
Sodium	quarterly	quarterly
Sulfate	quarterly	quarterly
Arsenic	quarterly	quarterly
Barium	quarterly	quarterly
Cadmium	quarterly	quarterly
Fluoride	quarterly	quarterly
Lead	quarterly	quarterly
Mercury	quarterly	quarterly
Nitrate (N)	quarterly	quarterly
Selenium	quarterly	quarterly
Silver	quarterly	quarterly
Endrin	quarterly	quarterly
Lindane	quarterly	quarterly
Methoxychlor	quarterly	quarterly
Toxaphene	quarterly	quarterly
2, 4-D	quarterly	quarterly
2, 4, 5-TP Silvex	quarterly	quarterly
Radium	quarterly	quarterly
Gross Alpha	quarterly	quarterly
Gross Beta	quarterly	quarterly
Coliform Bacteria	quarterly	quarterly

B. Second Year

pH	4 replicates twice/yr.	4 replices twice/yr.
Specific Conductance	4 replicates twice/yr.	4 replices twice/yr.
Total Organic Carbon	4 replicates twice/yr.	4 replices twice/yr.
Total Organic Halogen	4 replicates twice/yr.	4 replices twice/yr.
Chloride	annually	annually
Iron	annually	annually
Manganese	annually	annually
Phenols	annually	annually
Sodium	annually	annually
Sulfate	annually	annually

TABLE 8. SUPPLEMENTAL SAMPLING AND ANALYSIS FOR THE PERCHED-WATER ZONE

A. First Year

PARAMETER	GM-3, GM-5, GM-7, Spring A, & Spring B
pH	quarterly
Specific Conductance	quarterly
Chloride	quarterly
Sodium	quarterly
Sulfate	quarterly
Mercury	quarterly

B. Second Year

pH	semi-annually
Specific Conductance	semi-annually
Chloride	semi-annually
Sodium	semi-annually
Sulfate	semi-annually
Mercury	semi-annually

REFERENCES

Carlston, Charles W. and Graeff, George D. Jr., 1955, Geology and Economic Resources at the Ohio River Valley in West Virginia: Ground-Water Resources of the Ohio River Valley, Volume XXII, Part III, 131 pp.

Cross, Aureal T., and Schemel, Mart P., 1956, Geology and Economic Resources of the Ohio River Valley in West Virginia: Geology, West Virginia Geological and Economic Survey, Volume XXII, Part I, 147 pp.

Doll, W.L., Meyer, G., and Archer, R.J., 1963, Water Resources of West Virginia, West Virginia Department of Natural Resources, Division of Water Resources, 134 pp.

E. D'Appolonia Associates, 1958, Investigation of General Soil and Ground Water Conditions, Columbia Southern Chemical Corporation, Natrium, West Virginia.

Pettyjohn, Wayne A., 1976, Monitoring Cyclic Fluctuations in Ground-Water Quality, in Ground Water, Volume 1, November-December 1976, pp 472 - 479.

U. S. Department of Agriculture, 1960, Soil Survey of Marshall County, West Virginia, Series 1957, No. 4, 50 pp.

U. S. Environmental Protection Agency, 1980, Federal Register: Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities, Volume 45, No. 98, Part 265, May 19, 1980, pp 33239 - 33242.

APPENDIX A:

LITHOLOGIC LOGS OF SOIL BORINGS

GM-1

Elevation - top of outer casing:693.10 ft, msl

Lithologic Description	Depth (ft)	Thickness (ft)
Sandy loam, red brown	0 - 2	2
Clay, cinders, coal, sandstone fragments, red brown, moist	2 - 13	11
Gravel, poorly sorted, clayey, red brown, very moist	13 - 18	5
Clay, gravelly, coal fragments, red brown	18 - 23	5
Sand, medium to coarse grained, well sorted, red brown, coal fragments	23 - 43	20
Clay, stiff, red brown to yellow brown, weathered green to gray sandstone fragments	43 - 68	25
Silt, clayey, gray to yellow brown, iron stains	68 - 73	5
Clay, massive, plastic, gray	73 - 83	10
Silt, sandy, gray green to brown, sandstone fragments	83 - 93	10
Sand, silty, fine-grained, subrounded yellow brown, brownish-green gravel	93 - 96	3

GM-2

Elevation - top of outer casing: 709.88 ft, msl

Lithologic Description	Depth (ft)	Thickness (ft)
Silt, loam, brown, gravel	0 - 3	3
Clay, silty, brown to yellow brown, sandstone fragments, moist	3 - 33	30
Sand, medium grained, white to orange brown, rock fragments	33 - 43	10
Silt, clayey, tan to gray, wet	43 - 48	5
Clay, plastic, silty, red brown, weathered sandstone and coal fragments	48 - 93	45
Clay, gray to brown, coal and sandstone fragments, sand and silt lenses, moist	93 - 100	7
Mudstone, weathered, friable, gray, dry	100 - 106	6

GM-3

Elevation - top of outer casing: 721.99 ft, msl

Lithologic Description	Depth (ft)	Thickness (ft)
Clay loam, rock fragments, brown, micaceous, moist	0 - 3	3
Clay, plastic, stiff, rock fragments, brown, moist	3 - 23	20
Silt, clayey, gray-green, mottled, wet	23 - 33	10
Clay, stiff, red brown, sandstone fragments	33 - 50	17
Sandstone, friable, yellow brown to gray green, micaceous	50 - 55	5

GM-4

Elevation - land surface: 715 ft, msl

Lithologic Description	Depth (ft)	Thickness (ft)
Cinders	0 - 5	5
Sand, silty, medium grained, tan to brown, micaceous, plastic clay lenses	5 - 6.5	1.5
Clay, stiff, red brown, yellow mottling, sandstone and coal fragments, moist	6.5 - 29	22.5
Sand, silty, brown to orange, lenses of plastic clay, sandstone fragments	29 - 33.5	4.5
Silt, sandy, brown, rock fragments, moist	33.5 - 38	4.5
Sand, fine to coarse grained, poorly sorted, brown to tan, wet	38 - 41.5	3.5
Silt, clayey, gray, sandstone fragments, moist	41.5 - 48	6.5
Clay, silty, green to gray, sandstone fragments, micaceous	48 - 79	29
Mudstone, friable, gray to brown, dry	79 - 81	2

GM-5

Elevation - top of outer casing: 718.39 ft, msl

Lithologic Description	Depth (ft)	Thickness (ft)
Same as GM-4	0 - 50	

GM-6

Elevation - top of outer casing: 696.90 ft, msl

Lithologic Description	Depth (ft)	Thickness (ft)
Clay loam, orange brown, gravel, moist	0 - 3	3
Clay, dense, brown, gravelly	3 - 18	15
Sand, silty, medium to coarse grained, poorly sorted, brown, moist, sandstone fragments	18 - 41	23
Clay, dense, red brown, sandstone fragments	41 - 60	19
Silt, clayey, green, wet	61 - 64	3
Clay, stiff, red brown, sandstone fragments	64 - 75	11
Siltstone, friable, gray, micaceous, shaley	75 - 80	5

GM-7

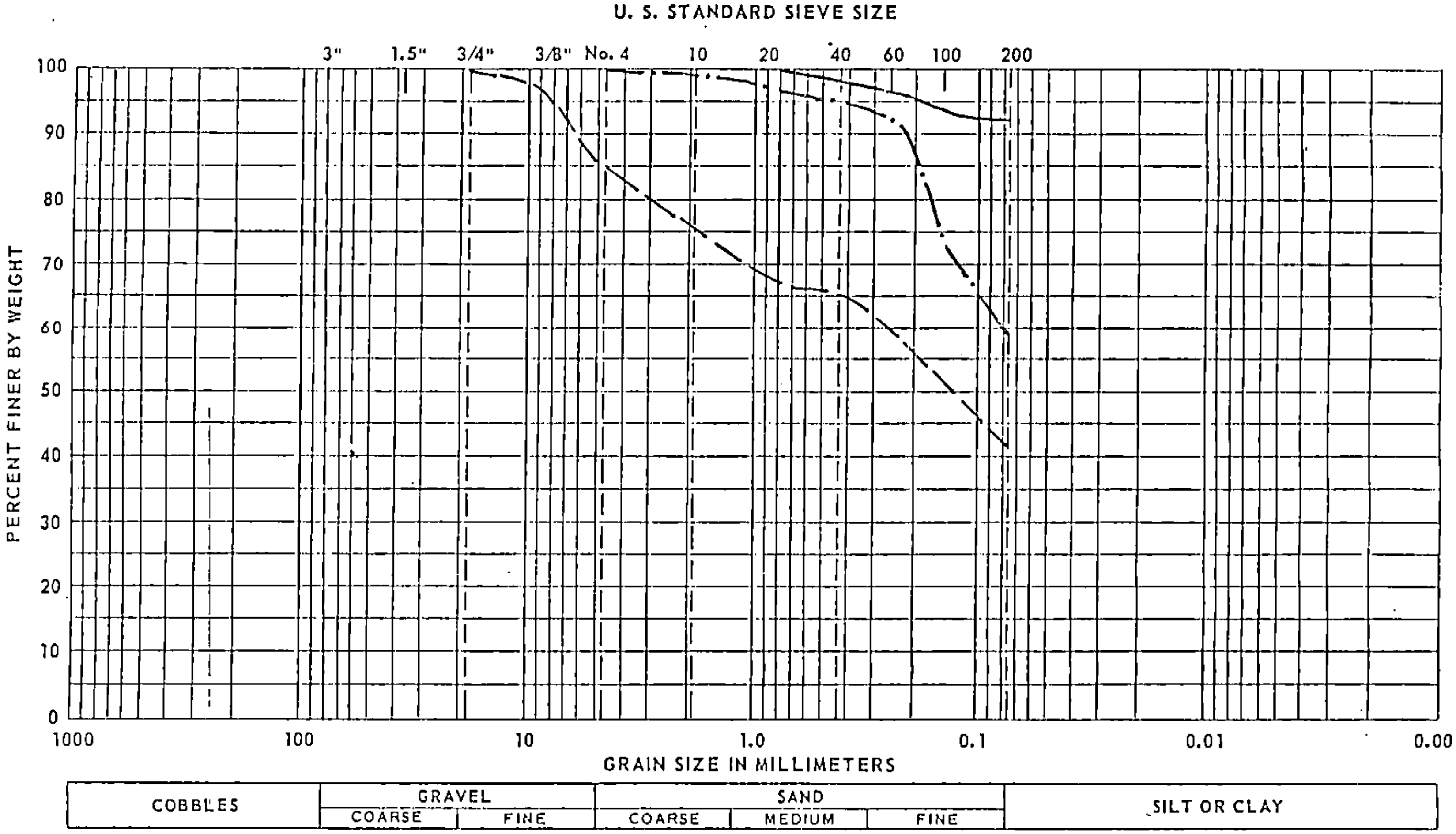
Elevation - top of outer casing: 710.74 ft. msl

Lithologic Description	Depth (ft)	Thickness (ft)
Same as GM-2	0 - 29.5	29.5
Sand, silty, fine grained, orange brown to tan, rock fragments	29.5 - 43	13.5
Clay, plastic, red brown, sandstone fragments, moist	43 - 56	13

APPENDIX B:

RESULTS OF SIEVE ANALYSES ON SELECTED SOIL SAMPLES

GRAIN SIZE DISTRIBUTION CURVE



SAMPLE NO.	BORING	DEPTH	LINE	CLASSIFICATION	NAT. WC	LL	PL	PI	REMARKS	PLOTTED BY:
TUBE	B-3	27.0-29.0	——	DULL GRN SILTY CLAY TRACE SAND	27%				FINE SANDS	NR
S-20	B-3	30.5-32.0	– –	LT GRN-BRN CLAYEY SILT AND SAND LITTLE GRAVEL	14%				FINE GRAVEL SUB/ [illegible]	NR
S-26	B-4	41.5-43.0	–·–	DULL GRN SANDY SILT	22%				TRACE CLAY	NR
			–··–							

GERAGHTY & MILLER INC.
PPG INDUSTRIES NATRIUM, W.VA.

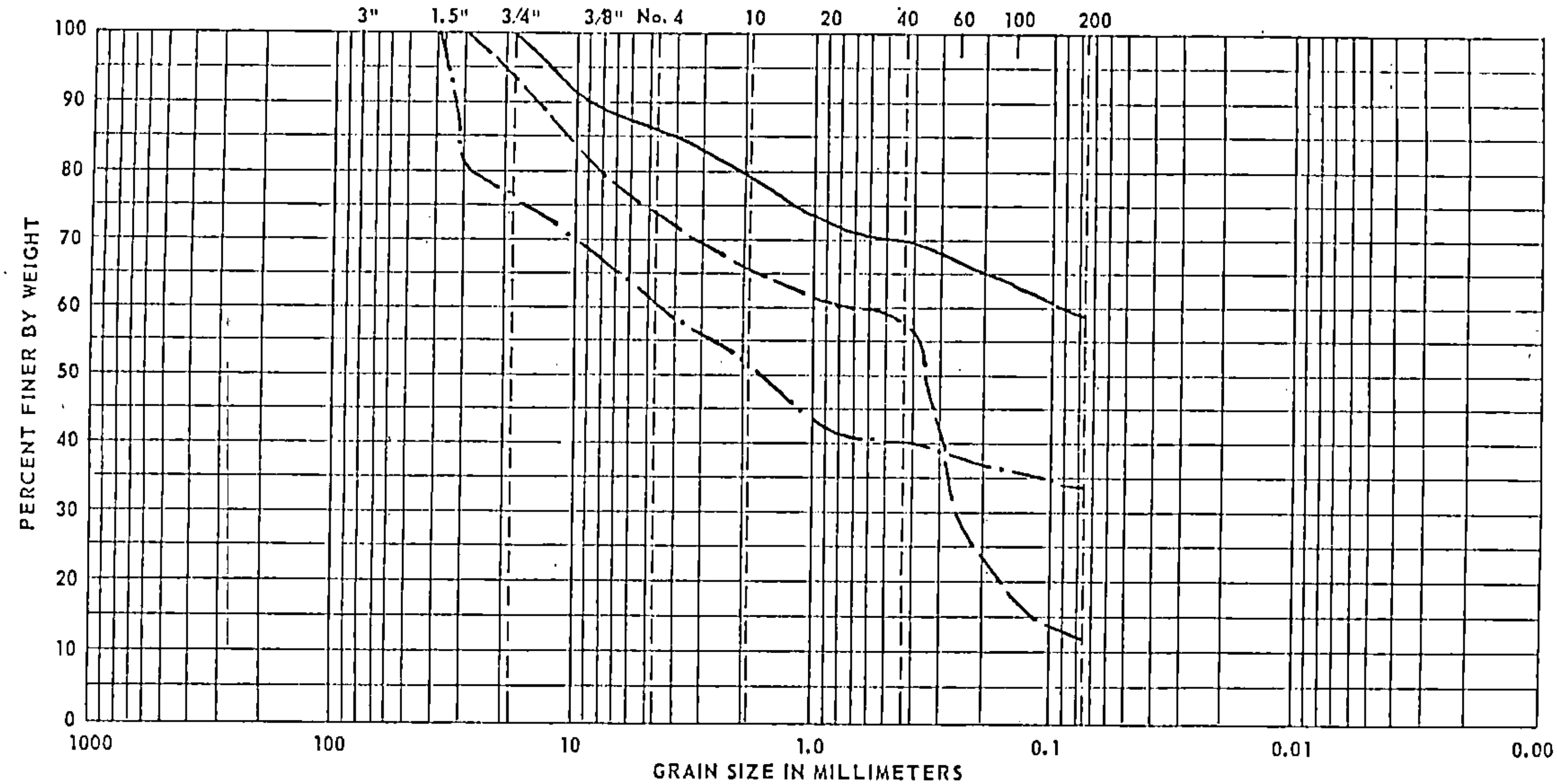
PITTSBURGH TESTING LABORATORY

ORDER NO. PLT 312

B-2

FORM NO. 1435

GRAIN SIZE DISTRIBUTION CURVE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

SAMPLE NO.	BORING	DEPTH	LINE	CLASSIFICATION	NAT. WC	LL	PL	PI	REMARKS	PLOTTED BY:
TUBE	B-2	11.0-13.0	——	DK BRN MED STIFF CLAYEY SILT SOME SAND LITTLE GRAVEL	14%				LITTLE F,M,C SANDS } SUB FEW F,M GRAVELS } ANGULAR	NR
S-10	B-2	34.5-36.0	— —	TAN BRN LOOSE SILTY SAND, SOME GRAVEL	7%				LITTLE FINES SOME F,M, GRAVELS-SUBANGULAR	NR
S-24	B-2	104'-105.5'	—·—	GRAY MED STIFF SILTY CLAY AND GRAVEL SOME SAND	7%				WELL GRADED SUBANGULAR SANDS AND GRAVELS	NR
			—··—							

PITTSBURGH TESTING LABORATORY

ORDER NO. BLT 317

GERAGHTY & MILLER INC.
PPG INDUSTRIES NATRIUM, W. VA.

FORM NO. 1435

11.87C 3.3A 16

INDUSTRIES

PPG INDUSTRIES, INC./BOX 191/NEW MARTINSVILLE, WEST VIRGINIA 26155/AREA 304/455-2200

Natrium Plant
Chemical Division–U.S.

January 18, 1982

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

RECEIVED
JAN 2 0 1982
LAW DEPARTMENT

Regional Administrator
U.S. Environmental Protection Agency
Region III
Sixth and Walnut Streets
Philadelphia, PA 19106

Dear Sir:

As required by the Resource Conservation and Recovery Act of 1976 [40 CFR 265.94 (a)(2)(i)], PPG Industries, Inc., is reporting the concentrations of the parameters in 265.92 (b)(1) for its first quarterly sampling of the groundwater monitoring wells at the mercury impoundment facility. This active facility is located at the Natrium, West Virginia, plant of PPG Industries, Inc., EPA I.D. No. WVD 004336343.

Attached are the first quarterly results for three downgradient wells (Nos. GM-1, GM-2, and GM-6) and a reference well (No. GM-0) in the uppermost aquifer. These analyses were reported from the laboratory on January 4, 1982.

The hydrogeological study performed prior to placement of the monitoring wells showed that there is no aquifer upgradient of the impoundment. The impoundment is located where the bedrock abruptly rises to a ridge above the impoundment. Downgradient wells are located in the uppermost valley alluvial aquifer, but, because of a heterogeneous mixture of colluvial or detrital material originating from the hillside, the water yield of these wells is poor.

Since it was not possible to take an upgradient sample, a reference well was chosen in the vicinity of the impoundment, but not directly downgradient, to provide a representative background groundwater quality in the uppermost aquifer of interest.

Section 265.94 (a)(2)(i) also requires the operator to identify separately for each monitoring well any parameters whose concentration has been found to exceed the interim primary drinking water standards. These are as follows:

Reference Well No. GM-0 – No parameter exceeded the standards.

	Parameter	Standard	Concentration Found
Well No. GM-1	Barium	1.0 mg/l	1.2 mg/l
	Cadmium	0.01 mg/l	0.083 mg/l
	Radium	5 pCi/l	9.0 ± 2 pCi/l
	Gross Alpha	15 pCi/l	16 ± 9 pCi/l
	Gross Beta	4 milli Rem/yr	43 ± 9 pCi/l
	Coliform Bacteria	1/100 ml	1500/100 ml

	Parameter	Standard	Concentration Found
Well No. GM-2	Cadmium	0.01 mg/l	0.043 mg/l
	Gross Beta	4 milli Rem/yr	19 ± 6 pCi/l
	Coliform Bacteria	1/100 ml	500/100 ml
Well No. GM-6	Cadmium	0.01 mg/l	0.041 mg/l
	Radium	5 pCi/l	5.7 ± 1 pCi/l
	Gross Alpha	15 pCi/l	12 ± 9 pCi/l
	Gross Beta	4 milli Rem/yr	13 ± 5 pCi/l
	Coliform Bacteria	1/100 ml	54,000/100 ml

These comments are pertinent to these first quarterly results.

1) No parameter was exceeded which is attributable to the impoundment.

2) Water yield is poor in these wells so that after pumping out the standing water in the wells, the incoming water was slow and generally very turbid. Turbidity reportedly affects radioactivity measurements. We are investigating this aspect.

3) We expect that the initial drilling activity contributed to the coliform bacteria, or perhaps the sampling procedure may have to be improved. There is no farm or septic system anywhere close.

4) A study is being made to see if any of the sampling or water level measuring equipment would include a cadmium compound. We would not expect to find cadmium as a result of any impoundment problem.

5) We expect that the ongoing quarterly monitoring will average out some of these random fluctuations.

If further information is needed, please contact me at this location.

Sincerely yours,

PPG INDUSTRIES, INC.
Natrium Plant

Warren E Dean

Warren E. Dean
Technical Manager

WED-CED:egm

Enclosure

bcc: T. G. Brown/D. E. Shenefiel
C. E. Drum
J. W. Osheka
R. J. Samelson
F. W. Steinberg
R. F. Mitchell
File

MERCURY IMPOUNDMENT
FIRST QUARTERLY MONITORING RESULTS
JANUARY 4, 1982
(Concentration in mg/l except as noted)

Parameters	EPA Maximum* Level Standard	MONITORING WELLS GM-0	GM-1	GM-2	GM-6
Arsenic	0.05	<.005	0.043	0.014	0.009
Barium	1.0	0.070	1.2	0.58	0.27
Cadmium	0.01	<.010	0.083	0.043	0.041
Chromium	0.05	<.010	0.022	0.012	0.022
Fluoride	1.4-2.4	0.8	1.4	0.7	1.2
Lead	0.05	<.010	0.031	0.018	0.016
Mercury	0.002	<.0002	0.0002	0.0002	0.0002
Nitrate (as N)	10	7.5	0.25	0.14	1.68
Selenium	0.01	<.005	<.005	<.005	<.005
Silver	0.05	<.010	<.010	<.010	<.01
Endrin	0.0002	<.0002	<.0002	<.0002	<.0002
Lindane	0.004	<.0001	<.0001	<.001	<.0001
Methoxychlor	0.1	<.003	<.003	<.003	<.003
Toxaphene	0.005	<.003	<.003	<.003	<.003
2,4-D	0.1	<.010	<.010	<.010	<.010
2,4,5-TP Silvex	0.01	<.010	<.010	<.010	<.010
Radium 226, 228 pCi/l	5 pCi/l	<0.6, <1	5.9 ±1.1, 3.1 ±1.4	<.6, <1	2.6 ±.8, 3.1 ±.2
Gross Alpha pCi/l	15 pCi/l	<2	16 ±9	<2	12 ±9
Gross Beta pCi/l	4 milli Rem/yr	<3	43 ±9	19 ±6	13 ±5
Coliform Bacteria	1/100 ml	<1	1500	500	54,000

*Section 265.92 (b)(1), Appendix III - EPA Interim Primary Drinking Water Standards, FR Vol. 45, No. 98, 5/19/80 33257

Geraghty & Miller, Inc.

WATER-QUALITY ASSESSMENT PLAN FOR THE PPG MERCURY POND

NATRIUM, WEST VIRGINIA

Prepared for

PPG Industries, Inc.

Natrium, West Virginia

GERAGHTY & MILLER, INC.
844 West Street
Annapolis, Maryland

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INTRODUCTION

In accordance with Federal and State requirements for groundwater quality monitoring at hazardous waste management facilities (EPA 40 CFR, Part 265, Interim Status Standards) PPG Industries, Inc., in Natrium, West Virginia intends to conduct a groundwater quality assessment in the area of their mercury surface impoundment (Mercury Pond, Figure 1). Geraghty & Miller, Inc., was retained by PPG to develop and implement the groundwater quality asessment plan required by the regulations. The following document constitutes the required plan.

The impetus for conducting this assessment comes after collection of the first year of background water-quality data and subsequent statistical comparison of those data to the first semi-annual sampling results. These comparisons indicated a statistically significant difference in background versus downgradient quality for the indicator parameters total organic carbon (TOC) and specific conductance (SC). Confirmation sampling indicated that the statistically significant difference was not the result of laboratory error.

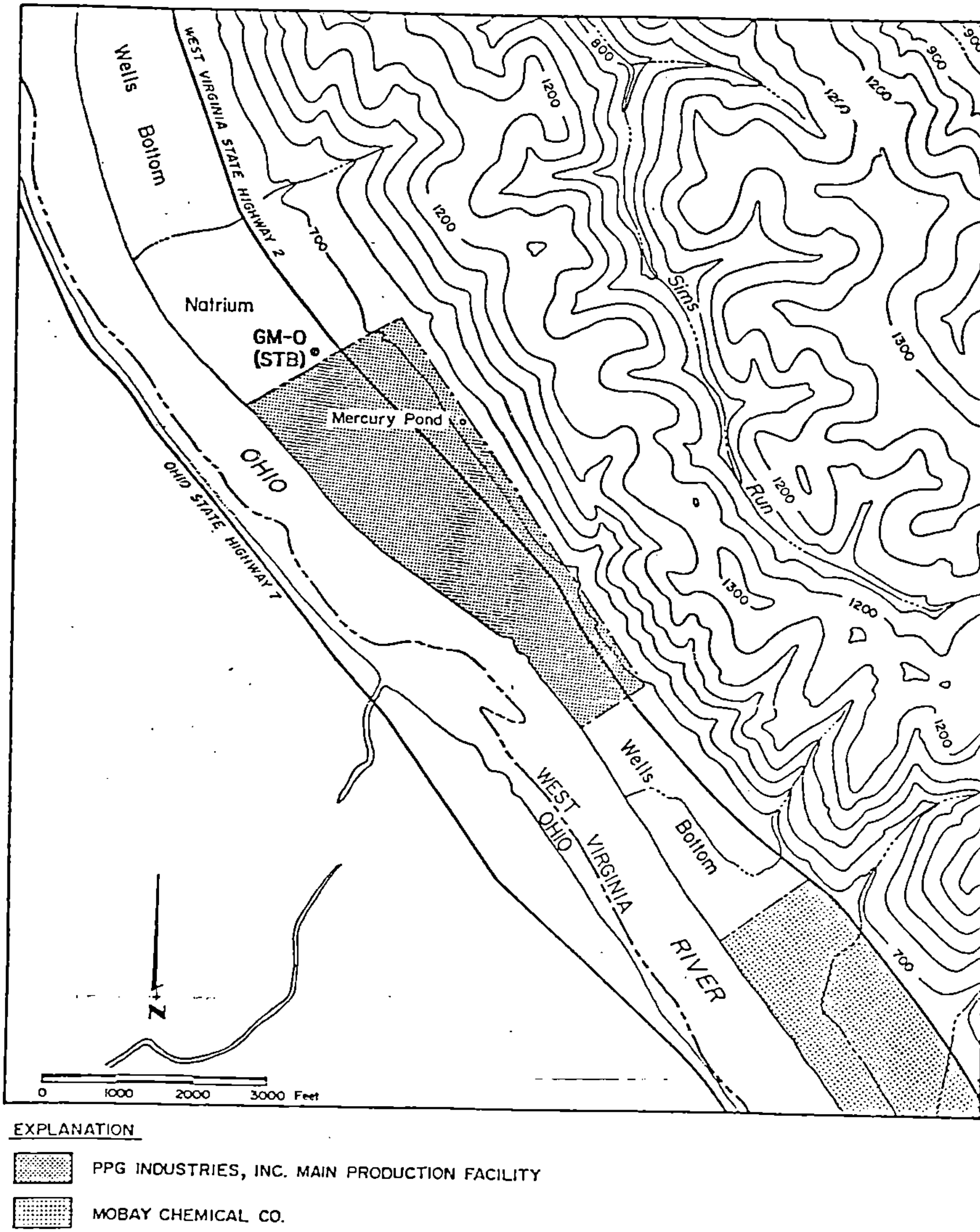


Figure 1. Location of the PPG Mercury Pond, Natrium, West Virginia.

Supplemental water-quality data generated throughout the course of the detection monitoring program suggest that these statistically significant differences for TOC and SC may not be related to holding practices at the Mercury Pond facility. In particular, statistically higher TOC levels are thought to reflect natural variations in fluid chemistry resulting from lithologic differences in aquifer matrix materials beneath the background and the downgradient monitoring locations, and statistically higher SC values are believed to be remnant from brine storage practices conducted at this site more than a decade prior to operation of the Mercury Pond. Because of these factors, PPG intends to implement a phased approach for conducting the water quality assessment.

The first phase (Phase I) of the water quality assessment will focus on determining if Mercury Pond holding practices are responsible for higher-than-background levels of TOC and SC in downgradient monitor wells. If findings indicate that the Mercury Pond is responsible, a second phase (Phase II) assessment will be implemented to determine, at a minimum: 1) the concentrations of specific hazardous wastes or hazardous waste constitutents in the groundwater, and 2) the rate and extent of migration of hazardous waste or hazardous waste constituents within the aquifer system.

The plan used to accomplish Phase I (and Phase II, if required) of the water quality assessment specifies the following information:

1) the number, location and depth of wells used in the assessment;
2) sampling and analytical methods to be utilized;
3) evaluation procedures including any use of previously gathered groundwater quality information; and
4) a schedule of implementation.

The subsequent sections discuss the information requested above, as well as additional information that will be collected and evaluated to adequately define the relationship (if any) between downgradient water-qualty trends and waste-holding practices at the Mercury Pond facility. For simplicity, these sections shall be presented as Phase I information requirements and Phase II information requirements. As noted earlier, the Phase II water quality assessment would only be implemented if Phase I findings indicated that the Mercury Pond is responsible for the statisitcally higher TOC and SC levels in downgradient wells, relative to background conditions.

PHASE I WATER QUALITY ASSESSMENT

Objective

The primary objective of the Phase I water quality assessment is to determine if the Mercury Pond is responsible for higher-than-background levels of total organic carbon (TOC) and specific conductance (SC) in downgradient monitor wells GM-1, GM-2, and GM-6.

Number, Location, and Depth of Wells

The existing monitor wells which have been utilized for RCRA compliance shall also be used to conduct the Phase I water quality assessment program. These include downgradient monitor wells GM-1, GM-2, and GM-6; well locations are shown on Figure 2. These wells are installed into alluvial deposits to depths of about 96, 99, and 75 feet, respectively, and are each equipped with a ten-foot-long screen section that intercepts the water-table aquifer; general monitor well construction is indicated in Figure 3. Lithologic descriptions of materials encountered at each well location and other information regarding hydrogeologic conditions near the Mercury Pond are presented in the report titled "Evaluation of Groundwater Quality Impacts at the PPG Mercury Pond," which was submitted to PPG in April 1981.

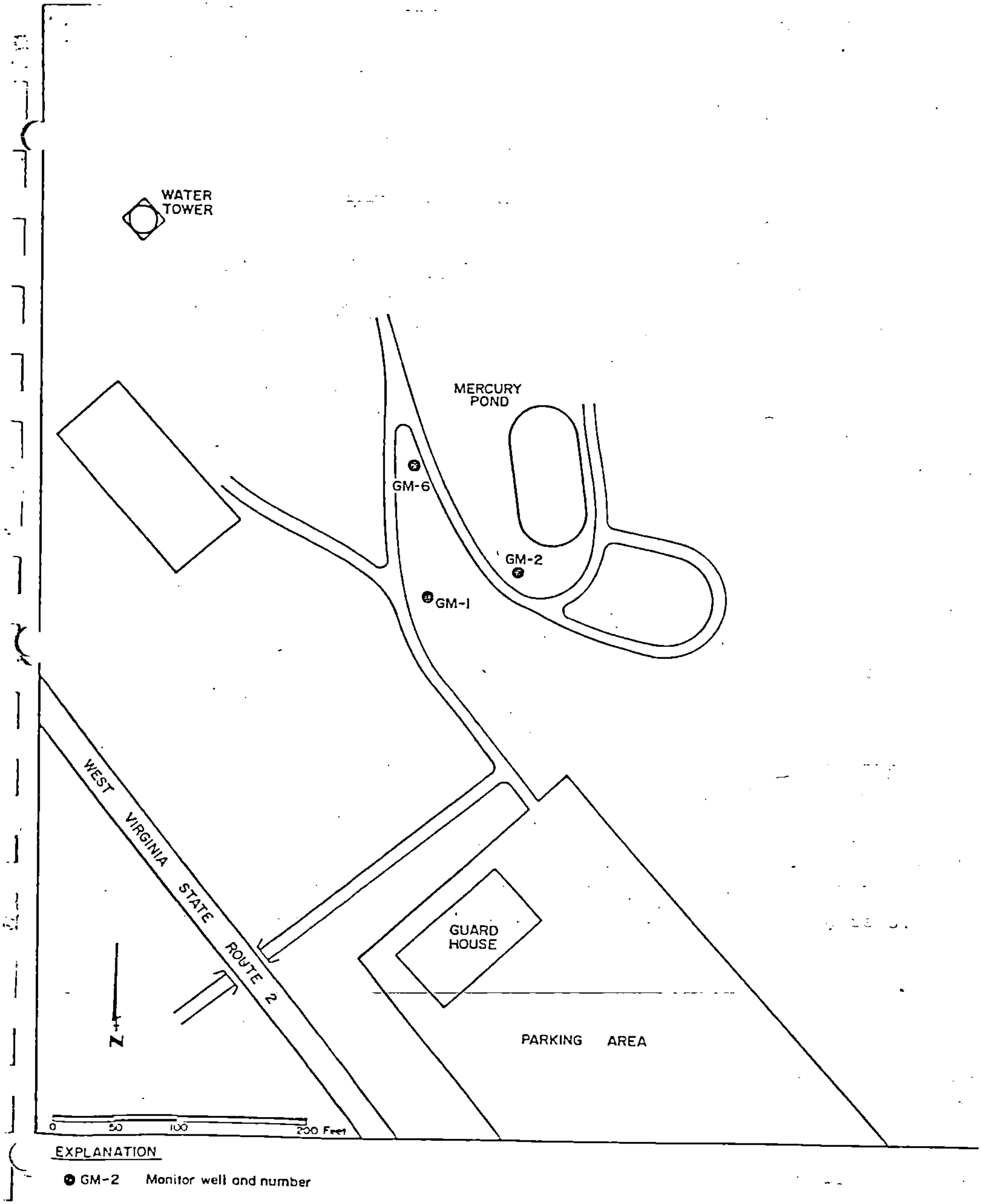
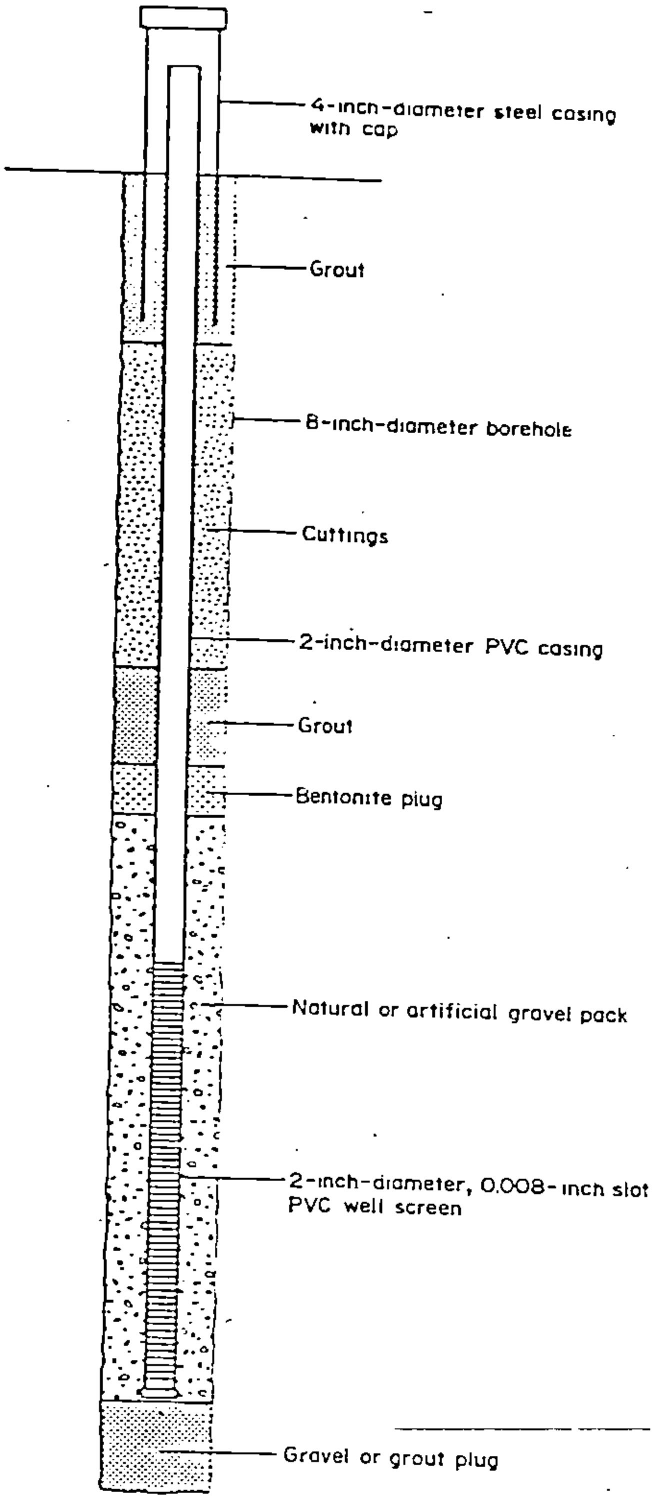


Figure 2. Location of Downgradient Wells at the PPG Mercury Pond, Natrium, West Virginia.



Well Number	Elevation* (ft)	Total Depth* (ft)
GM-1	693.10	99
GM-2	709.88	102
GM-6	696.90	78

* Measurement from top of outer casing.

Figure 3. General Construction of Downgradient Monitor Wells, PPG, Natrium, West Virginia.

In addition to monitor well sampling facilities, fluid samples shall be collected from the discharge (inlet) pipe to the Mercury Pond. The location of the Mercury Pond facility is shown on Figure 1.

Sampling and Analytical Methods

Two sets of groundwater samples shall be collected from downgradient monitor wells GM-1, GM-2, and GM-6. In addition, grab samples of Mercury Pond fluid shall be collected (from the inlet pipe) on the same day that groundwater samples are collected. All samples shall be collected in accordance with the document titled "Sampling and Analysis Plan for the PPG Mercury Pond, Natrium, West Virginia", which was prepared by Geraghty & Miller, Inc., and submitted to PPG in April, 1981.

All groundwater and pond fluid samples shall be analyzed for important water quality parameters including (but not limited to): pH, specific conductance, total organic carbon, total dissolved solids, bicarbonate, chloride, sulfate, calcium, magnesium, sodium, potassium, iron, manganese, silica, and mercury. Chemical analyses for these parameters shall be performed in accordance with the methods listed in the Sampling and Analysis Plan cited above.

Evaluation Procedures

The evaluation procedures for conducting this water quality assessment are as follows:

(1) Inspect water quality data (including supplemental data) generated throughout the course of the detection monitoring program. Parameters that were analyzed in addition to pH, SC, TOC, and TOX include: TDS, total alkalinity, bicarbonate, chloride, sulfate, sodium, potassium, calcium, magnesium, iron, manganese, and mercury.

(2) Identify parameters and/or parameter relationships that appear to relate to TOC and SC trends in downgradient monitor wells, and establish chemical parameters to be analyzed in subsequent water samples.

(3) Collect two seperate sets of water samples from the Mercury Pond (prior to treatment) and downgradient monitor wells GM-1, GM-2, and GM-6.

(4) Analyze both sets of water samples for the chemical parameters pH, specific conductance, TOC, TDS, bicarbonate, chloride, sulfate, calcium, magnesium, sodium, potassium, iron, manganese, silica, and mercury; these parameters have been selected based on findings from step (1), and in order to facilitate charge balance calculations to double check the overall accuracy of analytical results.

(5) Evaluate results of chemical analyses from previously gathered and new water quality information, and identify specific parameters and parameter relationships (e.g., Na/Cl ratios, main contributors to SC, major and minor fluid constitutents, pH, etc.) that characterize each fluid sample.

(6) Compare the chemical makeup of Mercury Pond fluids with the chemical makeup of groundwater in downgradient wells, and assess similarities and dissimilarities, and the extent to which the Mercury Pond may contribute to TOC and SC levels observed in downgradient monitor wells GM-1, GM-2, and GM-6.

(7) If, from this evaluation, the Mercury Pond does not appear to be the cause of the statistically significant change, notify the EPA Region III Administrator within 15 days of the determination and resume the normal indicator evaluation program under 40 CFR 265.92 and 265.93(b).

(8) If the Mercury Pond does appear to represent a likely source for higher-than-background TOC and/or SC levels in downgradient wells, implement the Phase II water quality assessment.

(9) Prepare a report to EPA Region III documenting the relevant findings of the Phase I water quality assessment, including the specific rationale and supporting data used to interpret water-quality trends beneath the Mercury Pond area.

Schedule of Implementation

The tentative schedule for implementing the Phase I water quality assessment is as follows:

	Task	Time Interval
1)	Collect and analyze two sets of water samples from the Mercury Pond and from downgradient monitor wells GM-1, GM-2 and GM-6.	October 10, 1983 to November 28, 1983.
2)	Evaluate results of water quality analyses and interpret and identify water quality trends and the relationship (if any) between Mercury Pond fluids and groundwater in downgradient wells GM-1, GM-2, and GM-6.	November 28, 1983 to December 5, 1983
3)	Prepare a report to EPA Region III documenting findings of the Phase I water quality assessment.	December 5, 1983 to December 15, 1983

PHASE II WATER QUALITY ASSESSMENT

Objectives

The Phase II water quality assessment shall be conducted if results from the Phase I assessment indicate that the Mercury Pond is responsible for higher-than-background levels of TOC and SC in downgradient monitor wells GM-1, GM-2, and GM-6. If the Phase II assessment is implemented, The main objectives, at a minimum, will include:

1. determine the rate and extent of migration of hazardous waste or hazardous waste constituents in groundwater, and
2. determine the concetrations of the hazardous waste or hazardous waste constituents in the groundwater.

Number, Location, and Depth of Wells

Existing monitor wells utilized for RCRA monitoring shall be included in the Phase II water quality assessment. These include downgradient wells GM-1, GM-2, and GM-6; and the GM-0 background well. Information regarding the location, depth, and general design of downgradient wells is presented in the Phase I plan. One (or more) additional downgradient wells shall also be installed to facilitate the Phase II assessment. It is anticipated that the additional well(s) will be installed to a depth of approximately 90 feet and will be screened into the top of the alluvial aquifer. The exact location(s) for the additional downgradient well(s) shall be determined based on which existing downgradient well(s) is(are) contaminated; the rationale for selecting locations of additional wells is presented in the "Evaluation Procedures" section of this Phase II plan.

In addition to sampling monitor wells, fluid samples will be collected from the discharge pipe (pretreated) to the Mercury Pond and the discharge pipe from the Mercury Pond to the carbon filter.

Sampling and Analytical Methods

Fluid samples shall be collected from: existing downgradient monitor wells GM-1, GM-2, and GM-6; new downgradient monitor wells; the GM-0 background monitor well; and the discharge pipe to and the discharge pipe from the Mercury Pond. All samples shall be collected in accordance with the document titled "Sampling and Analysis Plan for the PPG Mercury Pond, Natrium, West Virginia", which was prepared by Geraghty & Miller, Inc., and submitted to PPG in April, 1981.

All fluid samples shall be analyzed for important water-quality parameters including (but not limited to): pH, specific conductance, total dissolved solids, total alkalinity, bicarbonate, chloride, sulfate, sodium, potassium, magnesium, iron, manganese, silica, mercury, barium, cadmium, chromium (total), lead, total organic carbon, and total organic halogens; as well as other waste-specific parameters that may be recommended. All chemical analyses of fluid samples shall be performed in accordance with the methods listed in the Sampling and Analysis Plan referenced above.

Evaluation Procedures

If results of the Phase I water-quality assessment indicate that the Mercury Pond may be responsible for higher-than-background levels of TOC and SC in downgradient monitor wells (GM-1, GM-2, and GM-6), the Phase II water-quality assessment shall be implemented as follows:

(1) Evaluate Phase I water-quality data and (to the extent possible) identify the specific parameters causing contamination in the downgradient monitor well(s).

(2) Install additional downgradient monitor well(s). The location(s) of the additional downgradient monitoring well(s) is dependent upon which of the existing downgradient wells (i.e., GM-1, GM-2, and/or GM-6) are contaminated

a) If Well GM-2 or GM-6 is contaminated, additional monitor wells should be installed on either side of the affected well. In addition, monitor wells should be installed downgradient from the affected well(s). It may be necessary to install several sets of these downgradient wells to define the extent of contamination (see Figure 4 for potential locations).

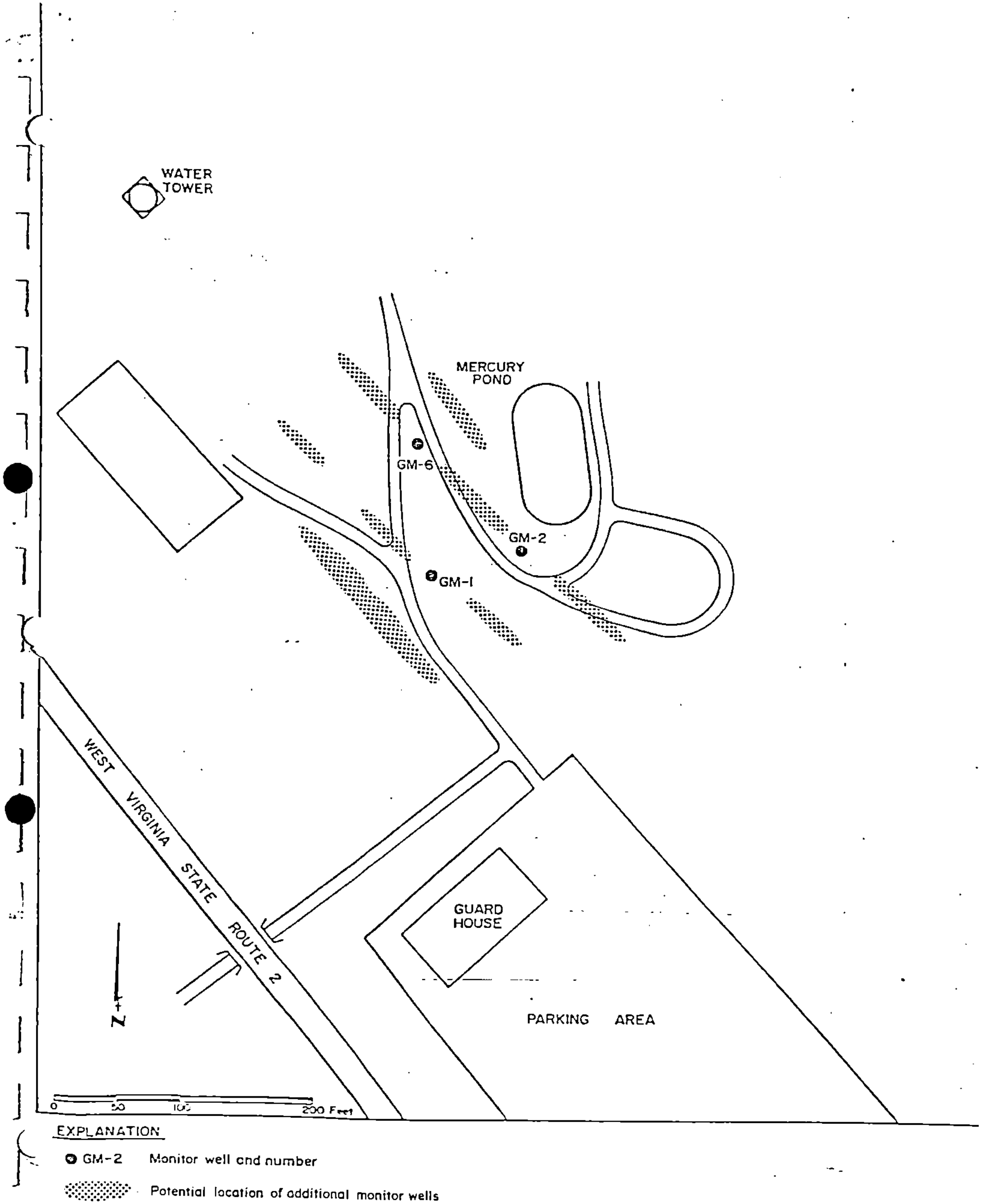


Figure 4. Potential Locations for Additional Downgradient Monitor Wells at the PPG Mercury Pond, Natrium, West Virginia.

b) If Well GM-1 is contaminated, additional monitor wells should be installed on either side of it. In addition, monitor wells should be installed on either side of GM-2, and one or more lines of monitor wells should be installed parallel to the terrace face and at least 20 feet west of GM-1. If more than one line of wells is installed west of GM-1, the well fronts should be at least 20 feet apart (see Figure 4 for potential locations).

c) The exact number and location of the additional monitor wells must be determined by the geologist or geotechnical engineer preparing the final Groundwater Assessment Plan.

(3) The hollow-stem auger drilling method shall be used to install all new 2-inch I.D. PVC monitor wells. Ten-foot well screens should be installed across the water table, above the top of consolidated bedrock. The estimated depth to the top of the screen will be approximately 80 feet. Soil samples should be collected during construction of the borehole. The annular space around the screen should be gravel packed. A bentonite plug shall be set above the screen and the remaining annulus shall be filled with cuttings that will be capped with at least 5 feet of bentonite or grout.

(4) On a weekly basis, collect three sets of water-level and water-quality data (i.e., sampling and measurements shall be collected once every seven days, over a three-week period). These data shall be collected from existing downgradient monitor wells (GM-1, GM-2, and GM-6), the GM-0 background well, the Mercury Pond, and newly installed downgradient wells. All samples shall be analyzed for the water-quality parameters specified in the Phase II Sampling and Analytical Methods section. All sampling and analysis procedures shall be in accordance with the Sampling and Analysis Plan referenced earlier.

(5) Via laboratory tests or pumping tests determine the permeability (hydraulic conductivity) of the earth material above and in the aquifer. These data will be needed to calculate groundwater flow rates.

(6) Determine the elevation of water in all wells and prepare a map of the water table depicting the direction of groundwater movement and the hydraulic gradient.

(7) Map results of water-quality analyses to determine the extent of groundwater contamination. Show concentration distributions for critical hazardous-waste constituents comprising the contaminated zone.

(8) Using available data on flow direction, hydraulic conductivity, hydraulic gradient, or other factors, estimate the rate of movement of the contamination.

Schedule of Implementation (Section 265.93(d))

(1) Within 30 days of the determination that the Phase II water-quality assessment must be implemented, begin installation of additional monitor wells.

(2) Within 60 days after installation of additional monitor wells, have results of all analyses completed and prepare a report defining the Rate and Extent of contamination.

(3) Within 15 days of completion of the report defining the Rate and Extent of contamination, report results to EPA Regional Administration.

Reassessments (Section 265.93(d))

(1) On a quarterly basis determine:

a) The rate and extent of migration of hazardous waste or hazardous-waste constituents in groundwater, and

b) The concentrations of the hazardous waste or hazardous-waste constituent.

(2) Reassessments must be made until the facility is closed.

(3) As needed, install additional monitor wells to assure the ability for continued compliance with Section 265.93(d).

Reporting and Record Keeping (Section 265.94(a))

(1) Annually report to the EPA Regional Administrator the results of the quarterly reassessments.

(2) Maintain all records during life of facility and through the post-closure case period.

Respectfully submitted,

GERAGHTY & MILLER, INC.

Cleason P. Smith

Cleason P. Smith, C.P.G. (Virginia #50)
Staff Scientist

Jeffrey P. Sgambat

Jeffrey P. Sgambat, C.P.G. (AIPG #4932)
Associate

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing Answer was served by first class mail on Friday, June 15, 1984, on the following:

Ralph Siskind, Esq.
U. S. Environmental Protection Agency
Region III
Curtis Building
Sixth and Walnut Streets
Philadelphia, PA 19106

June 15, 1984
Date

David C. Cannon, Jr.
David C. Cannon, Jr., Esq.
PPG Industries, Inc.
One PPG Place
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RCRA COMPLIANCE SECTION
RECEIVED
MAY 3 1984
RECEIVED
MAY 3 1984

May 2, 1984

Ralph Siskind, Esq.
U. S. Environmental Protection Agency
Region III
Sixth and Walnut Streets
Philadelphia, PA 19106

Dear Ralph:

At our meeting of April 2, 1984, PPG representatives expressed an interest in settling the EPA RCRA complaint without a formal hearing. EPA apparently shared this sentiment. Accordingly, at the end of that settlement conference, PPG agreed to submit a number of documents which EPA requested and to draft a proposed monitoring plan which would address the questions of the upgradient and downgradient wells and the parameters to be tested in view of the peculiar circumstances of PPG's mercury impoundment (e.g. erstwhile brine pond and lack of any water table upgradient).

It is still PPG's position that the enforcement action and the appurtenant fines are unwarranted. PPG made a good faith effort to comply with the regulations and hired Geraghty and Miller in 1980 to take advantage of that company's experience and expertise. PPG relied on the judgment and report of Geraghty and Miller and selected what PPG considered a reasonable monitoring program which complied with the RCRA requirements. As you know, in our informal settlement conference, there was disagreement even among EPA employees on the best location for an upgradient well. In fact, three EPA employees suggested two different approaches to the problem and three different locations for an upgradient well. In view of this, it is very difficult for PPG to accept a fine on the location of monitoring wells when the issue is so much one of judgment. This is especially true in light of PPG's having informed EPA of its use of the "reference" well in January of 1982, over two years before the complaint was filed.

The other basis of the complaint, the failure to comply with procedural notice requirements upon discovery of a statistically significant difference, was the subject of my letter to you dated April 3, 1984. At that time, I sent you a detailed assessment plan which documents the basis of the final report submitted to EPA in December of 1983. The citation and fine are, in my opinion, the result of the unfortunate loss of the final report by EPA. Thus, EPA and PPG had completely different views on PPG's compliance with the regulations. I can understand EPA's perception that PPG was taking no action, but now that EPA is aware of what PPG and its consultant were doing, it should be willing to drop the fine. To the extent that there was any procedural or technical noncompliance, it was cured prior to the complaint's being filed.

A number of documents are included with this letter. These documents fall into two categories:

A. Documents which reflect data or well logs which were requested by EPA.

B. Documents which constitute a proposal for groundwater monitoring put together by PPG to satisfy the concerns of EPA and the state.

The documents in Section A, which are those requested by EPA at our meeting, are as follows:

A-1 Core patterns for Brine Wells No. 1 and No. 2.

A-2 Organics and TOC analyses for mercury pond.

A-3 Analyses of perched water zones - Wells GM-3, GM-5 and GM-7.

A-4 Excerpted sections of plantwide Geraghty and Miller report which discuss hydrologic conditions that might have an impact on the mercury impoundment site.

Please keep in mind that PPG's willingness to take additional steps on the monitoring does not constitute any admission that its current program violates any federal or state regulations. As I told you in our settlement conference, the RCRA groundwater program is an evolving program and we have learned a good deal about the groundwater at Natrium since our initial installation. The proposed program is submitted in the interest of settling this claim and ending up with a monitoring system which is acceptable to PPG, EPA and West Virginia. PPG will require the agreement of both EPA and DNR to any consent decree or stipulation which results from our efforts to settle this matter. The attached proposal consists primarily of the following:

- Installation of two additional topographically upgradient wells in an attempt to discover a discrete section with sufficient water yield for sampling. These two wells are expected to be dry and unsuitable for monitoring, but will at least provide assurance that no upgradient well is possible in the immediate vicinity of the pond.

- Installation of one "upgradient" well to the north of the pond which should contain groundwater in the same aquifer and lithology as the downgradient wells, but which does not actually pass under the impoundment. One of these three upgradient will be selected for monitoring if yield and conditions are satisfactory.

- Installation of one downgradient well, essentially midway between two of the existing three wells (GM-1 and GM-6). This well will be completely screened in the aquifer/water table.

- If perched water is discovered during the installation of the deep downgradient well, a neighboring, shallow well shall be installed and monitored for mercury and pH.

- All existing and active seeps will be monitored for mercury and pH.

- With respect to the wells, rather than monitor for pH, specific conductivity, TOX and TOC, PPG will monitor for mercury and pH. Specific conductivity, TOX and TOC result in false positives and should not be part of any monitoring program.

NO

The above points are presented in more detail in the attachments. I am sending a copy of all of these documents to the West Virginia DNR and I propose that a meeting of PPG, EPA and DNR be held in Charleston or Philadelphia within the next two weeks to discuss this plan. Again, we do not want to make any commitment on well location and monitoring parameters until both agencies are in agreement. There is simply too much difference of opinion in this area for us to gamble that what is acceptable to EPA will be acceptable to DNR.

Please call me if you have any questions. I suggest a meeting the week of May 7 (with the exception of May 11). Please call me as soon as you have a made a decision on your availability for such a meeting. I assume that you will coordinate with West Virginia.

Sincerely yours,

David Cannon

David C. Cannon, Jr.
Senior Attorney

DCC/eb
cc: Robert L. Jelacic, DNR
Douglas Donor, EPA

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A. Documents requested by EPA

A-1. Core Patterns for Brine Wells No.1 and No. 2.

A-2. Organics and TOC analyses for mercury pond.

A-3. Analyses of perched water zones - Wells GM-3, GM-5 and GM-7.

A-4. Excerpted sections of plantwide Geraghty and Miller report.

B. Proposed Groundwater Monitoring Plan